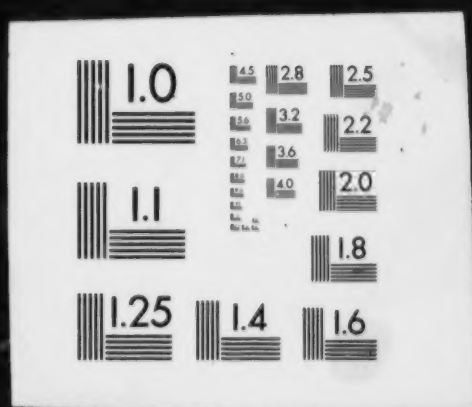


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Preliminary Feasibility of Energy Recovery with
Codisposal for Dekalb County, Georgia

CSI Resource Systems, Inc.
Boston, MA

Prepared for

Environmental Protection Agency
Atlanta, GA

Mar 80



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United States
Environmental Protection
Agency

Region 4
345 Courtland Street, NE
Atlanta GA 30308

March 1980

Solid Waste



A TECHNICAL ASSISTANCE PROGRAM REPORT

**PRELIMINARY FEASIBILITY
OF ENERGY RECOVERY WITH
CODISPOSAL FOR
DEKALB COUNTY, GEORGIA**

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Technical assistance by personnel teams. 42 USC 6913

RESOURCE RECOVERY AND CONSERVATION PANELS

SEC. 2003. The Administrator shall provide teams of personnel, including Federal, State, and local employees or contractors (hereinafter referred to as "Resource Conservation and Recovery Panels") to provide States and local governments upon request with technical assistance on solid waste management, resource recovery, and resource conservation. Such teams shall include technical, marketing, financial, and institutional specialists, and the services of such teams shall be provided without charge to States or local governments.

This report has been reviewed by the Project Officer, EPA, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Project Officer: Elmer G. Cleveland

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PRELIMINARY FEASIBILITY
OF
ENERGY RECOVERY WITH CODISPOSAL
FOR
DEKALB COUNTY, GEORGIA

PREPARED FOR
OFFICE OF SOLID WASTE MANAGEMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV, ATLANTA, GEORGIA

BY

CSI RESOURCE SYSTEMS, INC.

MARCH 1980

PREFACE

The report was prepared for DeKalb County, Georgia, under the U.S. Environmental Protection Agency's Technical Assistance Program to state and local governments interested in implementing resource recovery. The report was prepared as a result of a request to the U.S. EPA Region IV from the County Commission, supported by the Georgia Department of Natural Resources. This report contains the results of several site visits to DeKalb County by CSI Resource Systems, Inc., as well as numerous telephone conversations with county personnel. Resource Systems is a technical assistance contractor to the Office of Solid and Hazardous Waste, U.S. EPA Region IV. Under the terms of the Technical Assistance Program, the entire cost of Resource Systems' technical assistance activities on behalf of DeKalb County was paid for by the U.S. EPA.

The report presents the results of a preliminary determination of the feasibility of energy recovery with and without the cocombustion of sewage sludge. Such determination involved analysis of weighing records for solid waste handled by the county and county estimates of sludge generated at county sewage treatment plants; development and technical assessment of alternative energy recovery options; and study estimates of capital and operating and maintenance costs associated with the most viable energy recovery options. The study conclusion is that the county should give serious consideration to undertaking an in-depth feasibility analysis of energy recovery with codisposal of sludge, and suggests several technical, economic, financing, and legal/institutional areas that should be given special attention.

This report could not have been prepared without the generous cooperation of personnel from DeKalb County and the Georgia Power Company. Resource Systems wishes to thank especially the following individuals for their support:

Cliff Pruett - Department of Sanitation
James A. Nuckles - Department of Sanitation
John M. Spotts - Water and Sewer Department
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CHAPTER 1. OVERVIEW

The objective of this study was to make a preliminary assessment of implementing a resource recovery system in DeKalb County, Georgia. The assessment focused on recovery approaches using either municipal solid waste (MSW) or both MSW and sewage sludge (codisposal) to produce electricity for use by county facilities and/or for direct sale to Georgia Power (GP).

Currently, MSW and sewage sludge are disposed of separately, and no significant resource recovery exists. Most of the county's MSW is disposed of at the county-owned Seminole Road landfill. As part of the disposal system, the county owns and operates the Buford Highway and Exchange Park shredding plants and the Camp Road Transfer Station. Wastewater from the county is processed at five different locations--approximately 50 percent at the R. M. Clayton treatment plant in Atlanta; the remainder at the county's four facilities. Of these four, the Snapfinger plant accounts for 80 percent of the sludge generated in the county. Sludge produced at Snapfinger is disposed of in a gas-fired multiple-hearth incinerator. Sludge from the other three facilities is disposed of on-site.

This preliminary energy recovery feasibility study involved four major tasks:

- Determination of the current and projected quantities of solid waste and sludge generated within the county.
- Preliminary evaluation of available technical options suitable to the amount of solid waste and sludge generated and the identified energy market.
- Preliminary economic analysis of suitable energy recovery alternatives relative to current disposal costs.
- Determination of the justification for further detailed study and the associated necessary steps.

The results of each task are highlighted in the following subsections. In addition, suggested actions based on the results of this preliminary assessment are given.

Waste Quantity

According to county weigh data, solid waste tonnage has declined from 304,210 tons in 1975 to 274,089 tons in 1978. Comparison of weigh data for the first 6 months of 1979 with data for the comparable period in 1978 suggests that total tonnage for 1979 will be slightly higher than that for 1978. However, inspection of the pattern of solid waste tonnage generated in the county since 1975 indicates that the tonnage being generated is stabilizing in the range of 274,000 to 276,000 tons per year. Using the most recent population estimate of 440,800 persons served by the DeKalb County Department of Sanitation (DS), the 1979 estimated per-capita waste generation rate is 3.4 pounds per day, representing a significant decrease from the 1974 estimate of 4.8 pounds per capita per day.

The solid waste being disposed of in landfills daily represents a potentially valuable energy source. Based on laboratory analysis of the county's waste in 1975, each pound of waste being buried in the ground had an average heat value of approximately 5,300 British thermal units (Btu). If no significant change in the composition of solid waste has occurred since 1975, it is reasonable to expect that each ton of solid waste contains about 10,600,000 Btu.¹ In 1978, the total tonnage disposed of contained energy equivalent to approximately 191 million gallons of oil, 10,242 million pounds of coal, or 851 million kilowatt-hours (kWh) of electricity per year. In terms of oil, at \$0.70 per gallon, households and businesses in the county threw away the equivalent of nearly \$134 million worth of energy in 1978. With escalating conventional fuel prices, the value of solid waste can be expected to increase substantially over the next few years.

However, it must be recognized that, as in oil production, significant capital investment will be required to recover the energy contained in DeKalb's solid waste.

¹Henningson, Durham, & Richardson, Inc., Solid Waste Energy Recovery and Materials Reclamation Feasibility Study, prepared for DeKalb County, December 1975.

Solid Waste Generation. On the basis of current disposal data and adjusted county population projections, processible solid waste over the next 20 years will be:

	<u>Actual</u> <u>1978</u>	<u>1980</u>	<u>1985</u>	<u>1990</u>	<u>1995</u>	<u>2000</u>
TPD ₇ *	745	760	850	950	1,040	1,130

County personnel estimate that, by the year 2000, the capacity of the Seminole Road landfill will be exhausted at the present rate of disposal. If the projected annual tonnages materialize, the useful life of the Seminole Road landfill could be even less than the current estimate. Thus, if the county is to avoid a crisis in siting similar to that experienced in the acquisition of the current landfill, it needs to begin now to develop alternatives to total reliance on landfill as the disposal method.

Sludge Generation. According to county staff, an approximate total of 100 TPD₇ of wet sludge (15-percent solids) are generated and disposed of at the county facilities, which handle an approximate average of 24 million gallons per day (MGD) of municipal wastewater. The bulk of this total wet sludge, about 80 TPD, is produced at the county's Snapfinger facility, where it is thermally reduced in a gas-fired multi-hearth incinerator. The Snapfinger facility is currently being upgraded to an advanced level of treatment. According to county officials, by 1984, the Snapfinger Advanced Wastewater Treatment Plant (AWTP) will be able to handle 36 MGD (average) and sludge output should increase to 138 TPD (35-percent solids). The proposed codisposal energy recovery processes include drying the sludge, after which the 138 TPD will be reduced to approximately 60 TPD of dried sludge (80-percent solids).

Technical Options

County personnel determined that insufficient steam customers were available and that electricity appeared to be the most viable form of energy for production by an energy recovery facility. Two county

* TPD₇ is tonnage per day on a 7-day basis.

facilities--the upgraded Snapfinger AWTP and the water filtration plant--were identified as promising candidates for the utilization of the electricity produced. The selection of technical options was guided by two considerations. First, the county is interested in investigating the possibility of coincinerating sludge with solid waste to reduce the high energy costs associated with using natural gas to incinerate the increased tonnage of sludge that will be generated at the Snapfinger AWTP. Second, the county is interested in rehabilitating and retrofitting the existing (but closed) Camp Road incinerators because such an approach would take advantage of an existing capital investment and because the incinerators' central location could substantially reduce the significant haul cost associated with the current disposal system.

On the basis of solid waste disposal data and projected per-capita waste generation rates, it was determined that any recovery facility should be designed to handle 1,000 TPD, regardless of whether the codisposal or MSW burning mode was selected. With an assumed 85-percent plant availability and start-up of full-scale operations by 1985, an energy recovery facility for DeKalb County initially would need 1,200 TPD₇ of installed capacity.

Three technology alternatives were considered:

- Alternative 1: Rehabilitation and modernization of the two existing 300-TPD₇ rotary kiln incinerators at Camp Road, and on-site addition of a 600-TPD₇ mass-burning waterwall boiler (MBWW) producing steam to drive a condensing turbine generator. Under this alternative, either the MSW only or codisposal mode is possible. Electrical power generated would be wheeled via GP lines to the Snapfinger AWTP and the water filtration plant, and the balance of the power would be sold directly to GP.
- Alternative 2: Rehabilitation and modernization of the two existing incinerators at Camp Road to burn MSW only, and construction of a 600-TPD₇ MBWW at the Snapfinger AWTP burning both MSW and sludge, to produce steam and then generate electricity. The electrical power generated at the Snapfinger facility would be tied directly to the AWTP. The power at the existing facility would be tied into the GP grid for wheeling to the water filtration plant, with the balance sold directly to GP.

- Alternative 3: Construction of a new 1,200-TPD₇ MBWW plant at the Seminole landfill site for MSW burning only or at the Snapfinger site for codisposal of MSW and sludge to produce steam and electricity. If the plant were located at Seminole, electrical power would be wheeled via GP lines to the Snapfinger AWTP and the water filtration plant, and the balance in excess of county requirements sold directly to GP. If the plant were located at the Snapfinger site, the electrical power produced would supply the AWTP needs directly. The remaining output would be wheeled to the water filtration plant, with the excess sold directly to GP.

Economic Analysis

Estimated costs of the energy recovery alternatives versus current disposal costs are as follows:

	Energy Recovery MSW Disposal Only		Energy Recovery Codisposal			Current Disposal Systems	
	Alt. 1	Alt. 3	Alt.1	Alt.2	Alt.3	MSW	Sludge
Annual Net Disposal Costs (1984 \$1,000)	8,310	9,140	8,720	9,535	9,340	5,890 + 2,000 =	7,890

As is shown by this preliminary economic analysis, the Alternative 1 energy recovery codisposal option, which consists of upgrading the two existing incinerators at Camp Road and adding a new on-site MBWW boiler, has competitive economics for disposal of both MSW and sludge.* (For a more detailed summary of the economic analysis, see Chapter 4, Table 4-1, and Tables A-1 through F in the appendix for detailed cost estimates and calculations for bond requirements, annual debt services, operating and maintenance costs, and revenues.)

The comparison of the disposal costs of the various alternatives and current system indicates that:

- Current landfill disposal costs are likely to be substantially lower than the costs of energy recovery systems burning MSW only.
- The net disposal costs for energy recovery in the co-disposal mode are competitive with total 1984 disposal costs for separate MSW and sludge disposal using current shredding/landfilling and incineration methods.

*Moreover, the economics will become more competitive after the first year, as revenues will increase at a faster rate than operating and maintenance costs because of escalating fossil fuel prices.

- Use of the existing incinerators could result in lower net disposal costs when compared to the costs of a completely new facility, either MSW only or codisposal.
- The net disposal costs of a split codisposal system (Alternative 2) could exceed those of a codisposal system located on one site.

The economic comparisons fail, however, to reflect an extremely important dimension of the energy recovery options. Processing 1,000 TPD at an energy recovery facility will reduce the daily volume of solid wastes to be landfilled by 68 percent. If an energy recovery facility were put into operation within 5 years, the useful life of the Seminole Road landfill would be extended beyond the year 2000 by some 27 years. Thus, savings in land depletion (while not readily amenable to dollar and cents calculation) become a key factor in determining whether or not to invest in an energy recovery facility.

Conclusions

Preliminary results indicate that codisposal with energy recovery appears to be economically competitive with continued reliance on a shredding/landfill operation for solid waste disposal and incineration for sludge disposal. Therefore, the county should give serious consideration to undertaking an in-depth investigation and analysis of codisposal with energy recovery. Should the county decide to undertake such an in-depth study, there are a number of technical, economic, financing, and legal/institutional factors that will deserve special attention:

- Technical
 - Determine the feasibility of burning raw sludge without thermal predrying.
 - Assess the impact on boiler tubes of burning sludge containing chemicals, especially ferric chloride.
 - Conduct an engineering assessment of rehabilitating the existing rotary kiln incinerators and retrofitting them with waste heat boilers, suitable pollution control equipment, and a turbine generator. As part of this assessment, the adequacy and location of the existing stack should be analyzed.

- Determine the engineering feasibility of expanding capacity at the existing incinerators and whether new capacity should be a MBWW or additional rotary kiln units.
- Conduct energy audits of the Snapfinger and water filtration plants to identify energy conservation measures that could be implemented to reduce electricity consumption. As part of such an effort, a determination should be made of whether or not electricity requirements can be best satisfied by using output from an energy recovery facility or purchasing energy directly from GP.
- Determine the best location for an energy recovery facility to reduce overall disposal system costs (especially transportation costs) and to provide an environmentally and socially acceptable operation.

● Economic

- Establish a firm basis on which GP would purchase electricity; i.e., whether the energy recovery facility would be treated as a base-load facility with the price based on the company's system-wide cost of producing electricity or whether the price would be based on the company's fuel cost per kWh. (Note: Estimates used in the prefeasibility study assumed a resale rate based on fuel cost per kWh, a major reason for the relatively low energy revenue estimate.)
- Establish the full cost for both solid waste and sludge disposal. (It was learned in the prefeasibility study that county administrative costs charged to both the sanitation and water divisions were not included in cost data used, nor was amortization of acquisition and development costs of the Seminole landfill.) As part of this effort, additional development costs associated with the opening of any new sections of the Seminole landfill should be included.
- Develop budgetary estimates for capital and operating and maintenance costs for comparison of both energy recovery options and continued landfill and sludge incineration to narrow the range of cost estimating errors.

- Establish an equitable basis for allocating the net disposal costs of a codisposal energy recovery facility between solid waste and sludge in order to determine more accurately the charges to be paid by the sanitation and water divisions.

- Financing

- Determine the availability of federal wastewater treatment construction grants to finance a portion of the cost of a codisposal facility, as well as the basis for estimating the size of a construction grant.
- Determine if general obligation or revenue bond financing represents the more feasible financing approach. (This determination will in part depend on a decision on who should implement a recovery project.)
- Determine if the costs of turbine generators are likely to be capable of being financed with tax-exempt bonds or will require non-tax-exempt financing. In the event that non-tax-exempt financing is likely to be required, estimates should be made of the impact of such financing on project economics. In addition, interest by GP in purchasing the turbine generators should be explored, because in other recovery projects, notably those in Dade County, Florida; and Hempstead, New York; utilities have agreed to such a purchase.

- Legal/Institutional

- Evaluate the advantages and disadvantages of county sponsorship and financing of a codisposal energy recovery project versus implementation of a county Resource Recovery Development Authority, under Code Chapter 69-15a, to sponsor and finance a recovery project. Such an evaluation should take into consideration the implications on financing alternatives and the ability to procure systems on a competitive negotiated basis from a turn-key vendor offering system performance guarantees.
- Determine from the Public Service Commission those regulations likely to affect utility charges for wheeling electricity from publicly owned generating plants to other publicly owned facilities, including the ability of one public entity (e.g., a Resource Recovery Development Authority) to wheel electricity to facilities of a different public entity.

Immediate Actions To Be Undertaken

Among the factors previously identified as deserving special attention, several are strategic and should be immediately investigated by the county prior to a final decision to undertake a complete in-depth analysis of codisposal with energy recovery. Immediate actions that the county should consider undertaking are:

- Establish a firmer price for electricity as a starting point for negotiations with GP.
- Identify energy conservation measures that could be implemented at the Snapfinger and water filtration plants.
- Establish the full cost for both solid waste and sludge disposal.
- Determine the preferred locations for an energy recovery facility.

The establishment of a firmer electricity price is of paramount importance in determining whether or not to proceed with an in-depth investigation of energy recovery. Under the Federal Energy Regulatory Commission's proposed regulations implementing the Public Utility Regulatory Policies Act of 1978 (PURPA), public utilities are required to purchase electricity from cogeneration and small power production facilities of 80 megawatts or less using biomass, waste, and renewable resources as a primary source of fuel. The proposed regulations further stipulate that the price applied for such required purchases cannot exceed the incremental cost to the utility of alternative electric energy. To determine more definitively what the incremental cost of alternative electric energy is to GP (i.e., the highest cost fuel per kWh used by GP or the cost per kWh that would be associated with the next facility to be brought on line by GP), the county needs to hold discussions with GP to ascertain:

- The cost per kWh of GP's highest cost facility; the estimated cost per kWh of GP's next facility to be brought on line and the anticipated schedule; and the purchase price for electricity that GP feels the county should use in revising the economic estimates for an energy recovery project.

- The cost implications of GP's stated policy and specifications regarding parallel generation (i.e., tying power from a small power production facility into the GP grid) and whether such specifications are overly conservative.
- Interest on the part of GP in financing and operating an energy recovery facility for electricity production if the county were to guarantee delivery of the total processible waste disposed of in DeKalb. (It should be noted that, in Massachusetts, Boston Edison has announced a joint venture with a recovery systems vendor to build an energy recovery plant in the city of Boston. In addition, the Puget Sound Power & Light Company has recently indicated that it is willing to undertake an approach similar to that of Boston Edison in the Seattle/King County area).

In addition, the county should ascertain from the Georgia Public Service Commission (PSC) how it intends to comply with the proposed PURPA regulations. The county should also obtain from the PSC assurance that a power facility similar to that contemplated by the county would, in fact, be exempt from regulation as a utility. Finally, the county should obtain cost data from the PSC similar to that obtained from GP.

The information obtained from GP and the PSC should be used to reestimate the economics for an energy recovery project using the formula delineated in Chapter 4. In performing such revisions, the county should investigate the economic implications of selling all available electricity to GP versus selling only that amount in excess of the consumption at the Snapfinger and water filtration plants.

While the other three immediate actions identified above are self-explanatory, it should be noted that identification of energy conservation measures in the county plants is of importance for two reasons. First, the county may be able to reduce energy costs significantly at the two facilities. Second, knowing whether or not electricity consumption can be reduced will help to determine if only the excess portion or all of the available electricity produced should be sold to GP.

Only after accomplishment of all of the above activities and determination that the economics for an energy project appear favorable should the county seriously entertain procurement of consulting services

to perform an in-depth feasibility-procurement effort. After undertaking the four actions, the county will be in a much better position to structure the specific work to be undertaken by a consultant.

CHAPTER 2. SOLID WASTE AND SLUDGE GENERATION

In this chapter, current and projected waste generation data for the county are given. Data on waste tonnage are essential for determining the capacity requirements of an energy recovery facility. In addition, it is important to know the types of materials comprising the waste stream in order to determine the heat value or energy content of the waste. Knowledge of the heat value of the waste is necessary to calculate the amount of energy that can be recovered and marketed. While this investigation did not undertake a composition analysis, the results of a composition study conducted for the county in 1975 were used.²

Current Waste Generation

Estimates of waste tonnage are based on records and information maintained by the county. Solid waste tonnage data used in this report are based on weighing records of solid waste handled at county disposal facilities. Discussions with several large private haulers indicate that privately collected solid waste not handled by the county probably amounts to 5 percent of the total solid waste generated in the county. This estimate of the privately collected waste could not be verified within the time and funds available for the conduct of this prefeasibility investigation. It should be noted that this estimate is substantially lower than that contained in an earlier study prepared for the county.²

Data on raw sludge generated at the four county sewage treatment plants are based on process engineering estimates.

In 1978, the latest period for which complete annual records were available, 274,089 tons of solid waste were handled by the county disposal system. On a daily basis, the county handled 750 TPD₇. As pointed out later in this section, not all of the solid waste handled by the county is landfilled. Wet sludge production from the four sewage treatment plants amounted to 100 TPD₇ in 1978.

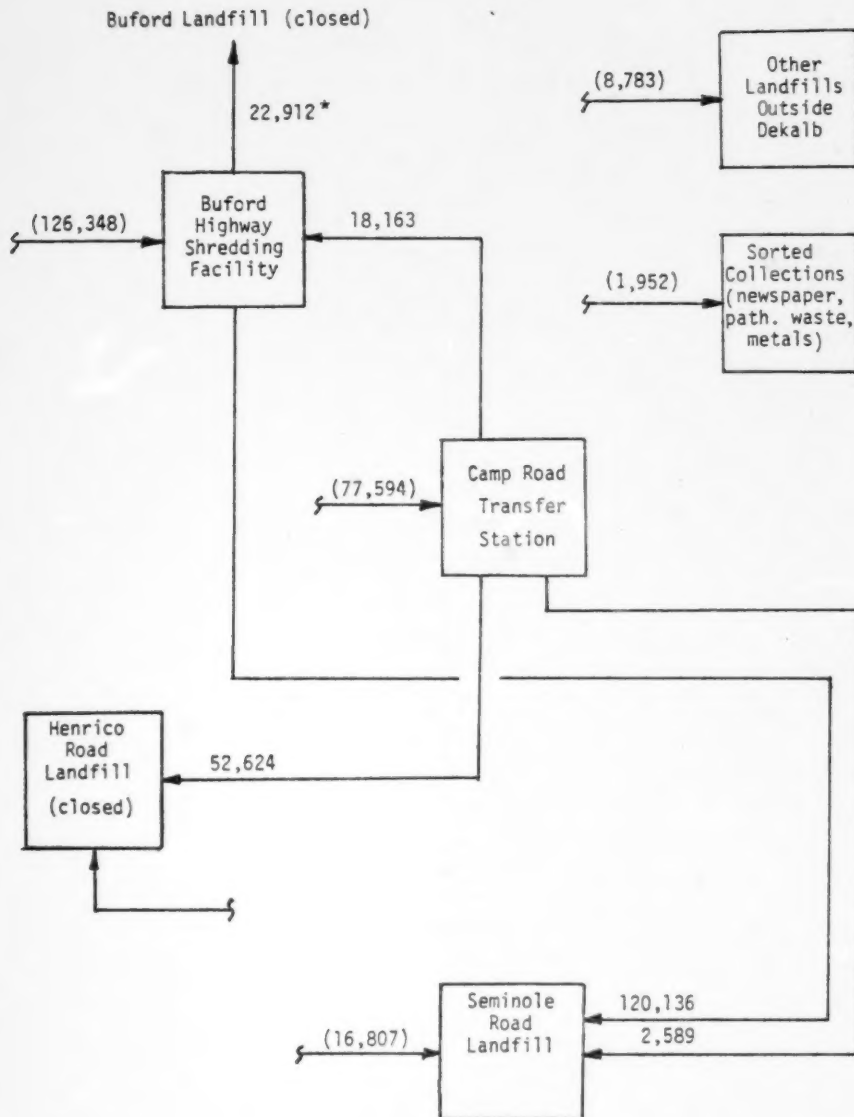
²Op. cit.

Solid Waste Generation. The county's DS currently disposes of most of the solid waste generated by the county. As previously noted, a small percentage of MSW (perhaps less than 5 percent) is handled by private contractors and disposed of outside county lines. The county owns and operates three waste-handling facilities, as well as the curbside collection system. In the northern part of the county, the DS operates the Buford Highway shredding plant, where two Eidal shredders, rated at 40 tons per hour each, process 500 TPD₅ (i.e., on a 5-day per week basis). In Decatur, at the site of the now-closed Camp Road incinerators, the DS operates a transfer station from which transfer vehicles transport the waste to the Buford Highway shredding plant for milling prior to landfill disposal at the DS-owned Seminole Road site in the southern part of the county. All waste must be shredded prior to disposal at the Seminole Road landfill. The DS also collects a small amount of MSW (3 percent of the 1978 total), which it hauls directly to private landfills outside the county, when it is more economical to do so than to haul it greater distances to the county's own facilities. Figure 2-1 shows the current flow of waste, including tonnages, as compiled from the 1978 county records.

The numbers shown in parentheses in Figure 2-1 are the tonnages delivered to the various facilities by DS vehicles, private haulers, and other institutions and agencies. The sum of these numbers--274,089 tons--is the total amount of waste generated in the county in 1978. The other numbers represent tonnages transferred internally from one facility to another.

In 1978, all waste other than that disposed of in landfills outside of DeKalb County and that separated from the waste stream was ultimately disposed of at the now-closed Buford landfill (22,912 tons), the now-closed Henrico Road landfill (95,229 tons), and the Seminole Road landfill (139,532 tons), for a total of 257,673 tons. However, as indicated by the parenthetical figures in Figure 2-1, the three landfills and the transfer station received a total of 263,354 tons. This slight discrepancy probably can be attributed to inaccuracies in weighing and/or record keeping.

FIG. 2-1. SOLID WASTE DISPOSAL SYSTEM FLOW FOR DEKALB - 1978



Note: Numbers in parentheses refer to the tonnages delivered to the various facilities by DS vehicles, private haulers, and all others. The figures not in parentheses refer to tonnages transferred internally from one to another.

*This figure represents the amount of MSW disposed of at the Buford Landfill for that portion of 1978 during which it was open.

Sludge Generation. Approximately half of the wastewater flow generated in DeKalb is processed at the R. M. Clayton treatment plant in the city of Atlanta. The remaining flow is treated at the county's four facilities. A breakdown of each facility's current capacities and the types of processes used is given below.

<u>Plant</u>	<u>Influent Avg.MGD</u>	<u>Treatment Description</u>
Honey Creek	0.3	Extended aeration with no digestion
Pole Bridge Creek	1.6	Extended aeration with aerobic digestion
Shoal Creek	3.0	Dual standard trickling filter with anaerobic digestion
Snapfinger	19.0	High-rate trickling filters, six package plants producing activated sludge, 10-MGD activated sludge plant
TOTAL	23.9	

Sludge generated at Honey Creek, Pole Bridge Creek, and Shoal Creek is deposited on drying beds at each site. All sludge produced at the Snapfinger plant is incinerated in a gas-fired multiple-hearth furnace. The furnace ash is then hauled to either the Seminole Road landfill or the three other wastewater facilities and substituted for sand in the drying beds.

According to plant personnel, sludge is discharged at the vacuum filters in the Snapfinger plant at a rate of 12 TPD (dry solids) at about 85-percent moisture. This amounts to 80 TPD of wet sludge being currently incinerated at Snapfinger. Assuming the same sludge conditions at the other facilities, from the total amount generated (23.9 MGD), approximately 100 TPD of wet sludge cake or 15 TPD of dry solids are produced either for disposal or incineration.

Projected Waste Generation

On the basis of DS and other waste generation data and adjusted population growth data, solid waste generation is projected to reach 863 TPD₇ in 1985, of which an estimated 850 TPD₇ would be processible.

Processible tonnage represents that portion of the total solid waste tonnage which would be available for processing at an energy recovery facility. The derivation of the processible tonnage estimate is discussed in detail later in this section. After increasing the county's wastewater treatment capacity at the Snapfinger plant (upgrading is currently underway), 138 TPD of wet sludge (35-percent solids) should be produced in 1984.

Solid Waste Generation. According to county records, the DS has disposed of the following tonnages of solid waste in the last 5.5 years*:

<u>Calendar Year</u>	<u>Annual Tonnages</u>
1974	302,685
1975	304,210
1976	276,785
1977	273,835
1978	274,089 (146,487 - 6 months)
1979 - 6 months	154,125

Because the county systematically weighs incoming waste at each of its facilities, these tonnages represent an accurate assessment of the generated waste.

To project future waste generation, population projections for the county are required. In its most recent estimate dated April 1, 1979, the Atlanta Regional Commission (ARC) computed the population of DeKalb County as 480,200. Of this total, 39,400 people reside within the city limits of Atlanta, leaving a net figure of 440,800, which is the best available estimate of the county population served by the DS. Assuming

*These figures do not include solid waste generated in the portion of Atlanta that is part of DeKalb County.

little change in the amount of waste generated from 1978 to 1979, the following approximate per-capita waste-generation rate can be computed*:

$$\frac{274,089 \text{ tons/year} \times 2,000 \text{ lbs/ton}}{365 \text{ days/year} \times 440,800} = \frac{3.4 \text{ lbs/capita}}{\text{day}}$$

The most recent long-range population projection for DeKalb, prepared in September 1977 by the Georgia Office of Planning and Budget and ARC, is:

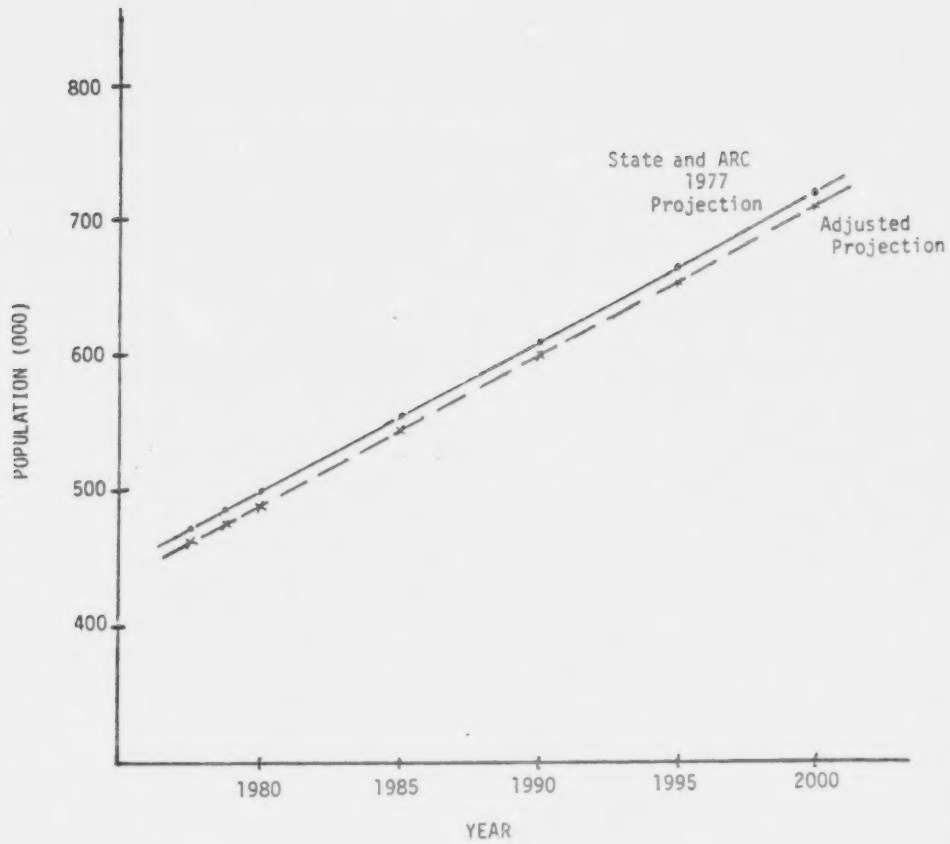
<u>Year</u>	<u>Population Entire County</u>	<u>Population Atlanta-in-DeKalb</u>	<u>Population Served By DS</u>
1980	500,200	37,400	462,800
1985	556,200	N.A.	N.A.
1990	610,600	37,900	572,700
1995	663,600	N.A.	N.A.
2000	715,700	37,700	678,000

The latest current population estimate of 480,200 (April 1, 1979) suggests that the above projections are high. The 1977 population projections assumed an unrealistic 4-percent growth from 1979 to 1980. Therefore, prior to developing solid waste projections using the 1977 population projections, adjustments were made to reflect the estimated growth rate from 1978 to 1979. In Figure 2-2, 1977 projections were plotted and extrapolated through 1979. Using the 1979 population estimate of 480,800 as a base, a second line was plotted representing an adjusted population projection. The adjusted population projections are:

<u>Year</u>	<u>Projected Population Entire County</u>	<u>Projected Population Atlanta-in-DeKalb</u>	<u>Population Served By DS</u>
1979 (est.)	480,200	39,400	440,800
1980	545,000	37,400	452,600
1985	545,000	37,400	507,600
1990	600,000	37,900	562,100
1995	655,000	37,900	617,100
2000	710,000	37,700	672,300

*Although waste generation data for the first 6 months of 1979 indicate a slight increase over similar data for the first 6 months of 1978, it is unlikely that 1979 total MSW generation will exceed the 1976 tonnage; more likely it will be around 275,000 tons.

FIG. 2-2. DEKALB COUNTY ADJUSTED
POPULATION PROJECTION



In the years 1985 and 1995, estimates of the population of Atlanta-in-DeKalb were not made; instead, the previous year's estimate was used.

Assuming that the per-capita generation rate of 3.4 pounds/capita/day remains constant, solid waste generation for DeKalb over the next 20 years is projected as follows:

<u>Year</u>	<u>TPD₇</u>
1980	769
1985	863
1990	956
1995	1,049
2000	1,143

Processible Waste Flow. Several categories of the waste generated would either not be processed at a resource recovery plant or would have been already separated from the waste stream and earmarked for other destinations. In some areas, newspapers, metals, and tires are collected and segregated from the waste stream by the DS and sold to scrap dealers. Appliances and bulk metal items are also sorted from the waste stream at each of the county's facilities. Pathological wastes are incinerated at a small gas-fired incinerator located adjacent to the existing rotary kiln incinerators. In 1978, these unprocessibles accounted for about 1 percent of the total incoming waste; assuming this percentage remains constant over the next 20 years, the net processible waste would be:

<u>Year</u>	<u>TPD₇</u>
Actual 1978	745
1980	760
1985	850
1990	950
1995	1,040
2000	1,130

Solid Waste Composition. A waste composition analysis undertaken in 1975 indicated that approximately 87 percent of the total waste generated

in the county comprises combustible materials.³ The remaining fraction of waste is composed of noncombustible materials, such as glass, metals, and other inorganics. Based on laboratory analysis of waste samples, the average heat value of county waste was 5,306 Btu per pound of waste, although the heat value ranged from a maximum of 8,580 Btu/pound to a low of 3,154 Btu/pound. This average heat value is substantially greater than the 4,200 Btu/pound to 4,600 Btu/pound generally used for estimating purposes in the absence of a composition analysis. If no appreciable change in waste composition has occurred, it would appear reasonable to expect that use of solid waste as a feedstock in a county energy recovery facility would provide in excess of 10 million Btu per ton of waste processed. The energy value per ton is equivalent to about 70 gallons of oil.* The thermal efficiency of combustion processes, however, would result in a net energy availability significantly less than that contained in the waste input.

Sludge Generation - Snapfinger AWTP. To comply with more stringent federal water effluent regulations and to increase the county's treatment capacity, the Snapfinger facilities are being upgraded to include advanced treatment. As a result of this plan, wastewater from Honey Creek will be force-mained to the Pole Ridge Creek plant, and the total raw influent will be pumped to Snapfinger AWTP. Influent from the Shoal Creek facility will flow by gravity to Snapfinger. The AWTP is projected to have an average influent of 36 MGD, generating 138 TPD of wet sludge at 35-percent solids.

Summary

The preceding discussion indicates that, by 1985, the county is likely to have a combined tonnage of processible solid waste and sludge (dry solids) of nearly 900 TPD, that will require disposal. Because of the energy value of this waste, it is important to consider how best to

³Op. cit., Table III-14, page III-24, and Table III-16, page III-28.

*The energy value equivalent per ton of MSW is calculated as follows:
 10.6×10^6 Btu (the Btu content per ton of MSW) $\div$ 6.3×10^6 (the Btu content per barrel of oil) $\times$ 42 = 70 gallons of oil.

recover that energy and convert it to a usable product. Chapter 3 presents a discussion of the technical options that appear best suited to recover energy from either solid waste only or from a combination of solid waste and sludge based on an assumption that electricity will be the final energy form to be produced.

CHAPTER 3. ENERGY RECOVERY ALTERNATIVES

In this chapter, the potential energy market and codisposal and MSW-burning technologies are described. In addition, three proposed energy recovery alternatives based on the quantity of waste to be handled, the requirements of the energy market, and available and applicable technologies are discussed. Finally, the underlying assumptions are given for the energy recovery calculations.

Two of the county's largest energy users are the Snapfinger wastewater treatment plant (currently being upgraded), located in Decatur, and the water filtration plant, located in the northern part of the county in Doraville. Together, these facilities consume approximately 7,790 kilowatts (kW). County officials have determined that these two large users are promising candidates for electricity produced from a waste-to-energy plant. Electricity produced in excess of the needs of these county facilities could probably be sold directly to GP.

To develop a plant serving this energy market, it would be necessary to tie power generated by the energy recovery facility into the GP grid for both wheeling to designated county facilities and direct sales to GP. This concept is referred to as parallel generation. GP's stated policy concerning parallel generation is to permit "any customer to operate his generating equipment in parallel with our electric system whenever this can be done without adverse effects on the general public or to our equipment or personnel." To meet these criteria, GP has issued a bulletin specifying the minimum design criteria and restrictions placed on customer power generation. The bulletin also states that the customer (i.e., the county) should bear the cost of equipment that must be installed to allow for parallel operation.

When upgraded, the Snapfinger plant will have an increased average capacity of 36 MGD. According to the consultant's design drawings, total horsepower requirements for the new and existing equipment to be used in the advanced treatment plant will be 4,677. This figure converts to 3,877 kW, or approximately 34×10^6 kWh per year, assuming the plant operates 24 hours per day, 365 days per year.

Power requirements for the water filtration plant were derived from the simple formula:

$$\frac{\$1,200,000}{\$0.035 \times 8,760} = 3,913 \text{ kW}$$

where:

- \$1,200,000 = the 1979 estimate of electric power costs
- \$0.035 = the present cost per kWh
- 8,760 = the number of operating hours per year.

Assuming this plant also operates 24 hours per day, 365 days per year, it too would consume approximately 34×10^6 kWh of power annually. Thus, total county use at the two plants was estimated at 7,790 kW.

Based on an estimated 850 TPD₇ (1985) of processible solid waste, electricity available for sale, after accounting for power needed for in-plant equipment, is expected to be about 15,000 kW from an energy recovery plant. After accounting for the total anticipated power requirements of the two county facilities, approximately 7,200 kW would be available for sale to GP.

Technology Assessment

The apparent absence of potential steam and solid fuel customers dictated that electricity be the form of energy produced from a DeKalb County energy recovery facility. Therefore, the alternatives evaluated in this preliminary feasibility study were limited to commercially proven recovery alternatives for the production of electricity. In addition, the assessment of technical options was guided by two considerations:

- The county's interest in investigating the possibility of coincinerating sludge with solid waste to eliminate the high energy costs associated with gas-fired sludge incineration at Snapfinger.
- The county's interest in rehabilitating and retrofitting the closed-down incinerators at Camp Road to take advantage of an existing capital investment and potentially lower hauling costs because of the incinerators' central location.

In this preliminary investigation, three major technical issues were addressed: the feasibility of converting the existing rotary kiln incinerators to produce steam and generate electricity; the energy recovery technology used for the new systems; and the technology involved in pre-drying sludge for coincineration with solid waste.

Solid Waste Disposal. For the purposes of this preliminary feasibility study, the alternatives under consideration were limited to technologies that are commercially applied throughout the world to generate electricity from MSW. The two existing incinerators at Camp Road are similar to power generating units manufactured by Volund in Europe. Other commercial technologies at the DeKalb County scale that have proven to be economically practical include MBWW and refuse-derived fuel (RDF) produced for firing in new boilers.

In-depth engineering estimates of the capital and operating, maintenance, and repair expenses (OM&R) of mass-burning waterwall combustion and dedicated boiler system firing RDF have recently been performed for the cities of New York⁴ and St. Louis.⁵ The results of these two studies indicate that capital and OM&R costs of comparably sized mass-burning and dedicated boiler technologies are likely to be competitive. For the purpose of this analysis, the two technologies may be considered as interchangeable in terms of reliability, availability, maintainability, and project economics.

The ultimate choice between the waterwall combustion and dedicated boiler technologies can only be made after detailed customer and site-specific information is acquired and evaluated to ensure that an optimal system is ultimately implemented. Thus, expanded capacity beyond the 600 TPD represented by the Camp Road incinerators will be assumed to be provided by MBWW boilers.

While preliminary information from equipment manufacturers has suggested that plant availability for the converted rotary kilns would be

⁴CSI Resource Systems, Inc., Technical Assessment of 3000 TPD Resource Recovery Alternatives for New York City, June 1979.

⁵CSI Resource Systems, Inc., A Feasibility Analysis for the Implementation of a Regional Resource Recovery System in the St. Louis Area, prepared for the Bi-State Development Agency, February 1979.

in the 80-percent to 85-percent range, actual experience has shown it to be less than that of waterwall systems. Furthermore, overall thermal efficiency of refractory furnaces using waste heat boilers is somewhat less than the mass-burning waterwall system. The quality of steam raised is also somewhat less. For study purposes, however, it has been assumed that the converted rotary kiln units are comparable in operating characteristics to MBWW units.

Codisposal. Because of the high percentage of water present in most municipal sludge, substantial amounts of costly fossil fuels are required in sludge incinerators to evaporate the water, thereby enabling combustion of the solids portion. In an effort to find a less energy-intensive disposal alternative, a number of municipalities in the United States and Europe have been exploring the concept of codisposal--the combining of two disposal problems (sewage sludge and MSW) into an environmentally acceptable process and into the production of energy.

Basically, three methods of codisposal have gained recognition as being potentially feasible for long-term disposal of solid waste and sludge. These methods are cocomposting, codisposal using existing sludge incinerators, and coincineration using solid waste incinerators. In the following paragraphs, each method is described and then discussed in terms of its technical feasibility for DeKalb County.

Cocomposting has been shown to be technically sound and economical in small-scale projects, and is currently being expanded to larger scale projects. For example, the Delaware Solid Waste Authority intends to install cocomposting using Fairfield-Hardy aerobic digestors modeled after the mechanically mixed and aerated, high-rate digester in the Altoona, Pennsylvania, plant. In the Los Angeles area, sewage sludge has been composted using windrow techniques with wood chips and has been sold to park authorities, golf courses, nurseries, and landscaping contractors. However, in the face of competition from commercial fertilizers, marketing large quantities of low-nutrient-value soil supplements with trace metal concentrations is problematic. Even when giving compost away, American projects have typically been unable to dispose of all of their product. Altoona, Pennsylvania, and Washington, D.C., boast the

most successful cocomposting projects. One German corporation is proposing the use of compost as a fuel. Analyses of samples from a New York City pilot plant indicate that such material could be a relatively good fuel and usable in boilers that fire solid waste.

Despite their technical success, most projects have closed because of inadequate markets. For this reason, cocomposting would likely not be economically feasible for DeKalb, given the identified market demand in the county.

Two types of codisposal sludge incinerators are in general use today--multiple-hearth and fluidized-bed furnaces. Of the two, multiple hearths are the more prevalent.

The most noteworthy experiment with codisposal using multiple-hearth furnaces is the Contra Costa, California, project. The objective of this full-scale test was to show that RDF and sewage sludge codisposal was technically feasible. Field testing began May 24, 1976, and was completed July 30, 1976. A number of different test runs involved incineration and pyrolysis modes of operation and various feed rates, feed methods, and RDF-to-sludge ratios. The longest continuous run under any one mode of operation was slightly over 8 hours, and operating problems similar to those usually encountered with multiple-hearth furnaces, e.g., slagging, occurred. At the present time, Contra Costa County plans an extended test so that the system can be evaluated during a 2,000-hour continuous run before it decides to commercialize the technology.

A codisposal project using multiple-hearth furnaces is planned for Memphis, Tennessee. The city of Memphis has been offered an EPA grant for the project. Because of the high technical risk and innovative nature of the project, federal underwriting of extraordinary maintenance expenses is provided for the entire system through the first 2 years.

Relatively successful codisposal has been achieved daily in the fluidized-bed incinerator at Franklin, Ohio, since early 1972. The plant is now closed because of economic failure of the wet-separation-based refuse-processing scheme. The hydropulper-based system is, however, the prototype of two large resource recovery plants that are expected to be economic. At Franklin, sludge is dewatered in mechanical presses with the pulped solid waste. Fifty-percent solids material is then injected

into a high-temperature bed of "boiling" sand in the Dorr-Oliver fluidized-bed sludge incinerator. The abrasion of sand particles on the sludge makes additional dewatering unnecessary, and good burnout is achieved.

Codisposal with shredded, instead of pulped, waste has been tested in several limited duration experiments. The city of Duluth, Minnesota, is starting up its new fluidized-bed codisposal plant. The variability and low melting temperature nature of sludge solids make reliable operation of such plants difficult. During a major combustion upset, the sand bed can fuse, necessitating extensive repair. Differences in material density between sludge and bed media further complicate the problem.

Because both the multiple-hearth and fluidized-bed codisposal techniques are still in the developmental stages and utilize RDF, rather than unprocessed MSW, they were not considered in this preliminary study. If future operating experience shows these systems to be technical successes, a next-phase study could include evaluation of RDF-based codisposal systems.

Solid waste incinerators are sometimes used for combustion of sludge and solid waste, either with direct burning of sludge or with sludge drying prior to incineration. Of the two, sludge drying prior to incineration has proven to be more successful.

Early attempts focusing on coincineration have proven largely unsuccessful. In 1975, 13 out of 17 plants designed for coincineration had either shut down, no longer burned sludge, or had never succeeded in starting up the sludge management portions of the plants. Some of the most frequently cited reasons for system failure include problems of mixing wet sludge and refuse, improper control of furnace feed, incomplete burnout of sludge, and dousing of the fire.

Many of these problems are inherent in the mechanical handling and combustion of sludge in grate-fired incinerators. For example, if sludge is sprayed into an incinerator, tramp materials in the sludge rapidly plug nozzles and orifices, thus preventing sludge injection. Coincineration of wet sludge mixed with refuse on the grates avoids this problem, but is limited to thinly spread layers of very wet sludge to allow complete

burnout. (When sludge burns, layers of ash, char, and tars form, which surround the pieces of sludge. These insulating layers prevent the complete burnout of the sludge in practical grate-fired incinerators.)

Rotary kiln incinerators, similar to those at Camp Road, however, have a multi-stage burning process in the rotary kiln incinerator combustion train with sufficient agitation of the ash to encourage complete sludge burnout without thermal predrying. This idea would be worthy of further consideration in the next phase of this study.

Experience has shown that grate-fired coincineration installations use some sort of mechanical sludge dewatering, followed by thermal predrying using waste heat. The temperatures required for predrying are not high enough to cause coking and consequent retarded drying rates. In addition, the drying process usually reduces the size of sludge particles for good combustion when fired in an incinerator. The proven sludge predrying techniques involve either direct or indirect drying.

In direct drying coincineration, some of the exhaust gases from the incinerator dry dewatered sludge by direct contact in a spray drying chamber. Because this direct gas-solids contact results in contamination of the gases with pollutants and odors, the gases must be recycled to the incinerator for deodorization and particulate removal. Recycling this water-vapor-laden gas to the furnace, however, may cause a reduction in the amount of steam available for electricity generation. The dried sludge solids are usually carried into the incinerator by the drying gases where the powdered sludge is burned in suspension.

Suspension firing--whether of sludge or RDF--offers several advantages over conventional mass firing in that more complete burnout is attained and less excess air, which wastes heat, is used. Two disadvantages are that the fuel must be fairly homogeneous, and particulate carryover to the pollution control equipment will increase.

Both American and European coincineration plants have several years of operating experience. Developmental problems have been encountered in the equipment being employed, but the overall viability of the concept has been proven. The process for the drying of sewage sludge with hot fuel gases to prepare "MilOrganite" for use as a soil supplement has more than 10 years of operating experience in Chicago and Houston. The

integration of this equipment and the specific mechanical details of various emerging systems to improve reliability and cost performance are being demonstrated in Holyoke, Massachusetts; Ansonia, Connecticut; and Krefeld, West Germany. Other European plants are operating reliably using similar technology.

Indirect drying coincineration basically involves a heat exchange process whereby heat (usually from steam) is passed through a heat transfer surface and into the sludge. Water is driven out of the sludge without the steam ever coming in contact with the sludge. The dried sludge solids are charged with the refuse into an incinerator. Heat transfer using indirect drying is usually more efficient than direct drying, such that equipment sizing is considerably smaller. An additional advantage to this system is that the volume of contaminated water to be deodorized in the incinerator is substantially reduced. The vapor consists only of contaminated water vapor from sludge drying, instead of the water vapor-flue gas combination present with the direct drying technique. Unless the moisture is condensed and treated prior to discharge to a sewer, the gas must be recycled to the furnace, a process that will reduce the amount of steam for electricity generation. Typical dryers used in this process are shell and tube heat exchangers, wiped surface evaporators, steam tube rotary dryers, and thin film evaporators.

The use of steam-driven drum and gear dryers to reduce the moisture content of sewage sludge to the point where it will burn in conventional incinerators is a technology employed in many European plants. The Dieppe, Deauville, and Brive plants in France have all been predrying sludge in this manner since the late 1960s. Within the next year, the city of Harrisburg, Pennsylvania, will commence operation of a codisposal plant where dried sludge and solid waste will be coincinerated in an existing solid waste waterwall incinerator. Partially dewatered sludge from the nearby advanced wastewater treatment plant will be dried by steam from the boiler in heat-exchanger type dryers, called Porcupine Processors, made by the Bethlehem Corporation. Vapor generated in the dryers will be evacuated to a condenser, in which condensables will be removed by circulated effluent from the wastewater treatment. The noncondensables will be blown to the furnace combustion chamber for odor elimination. The dried sludge will be pneumatically conveyed to the furnace.

The ultimate selection of drying technology would occur after more detailed engineering studies of the alternatives proposed in this report were undertaken. It is felt that the experience to be gained at Harrisburg will help to determine the benefits of indirect steam drying. However, at this point in time, successful operation of the Krefeld plant in West Germany has proved that a direct sludge drying technique can work effectively in an energy recovery coincineration system. For this reason, the codisposal alternatives evaluated for DeKalb County were based on the direct drying technique. Regardless of the codisposal technology used, care must be taken in the selection of sludge conditioning agents to ensure that they do not interfere with reliable boiler operation by enhancing corrosion or fouling.

Recovery Alternatives

On the basis of solid waste disposal data and the projected per-capita waste generation rate, it was determined that any recovery facility should be designed to handle 1,000 TPD, regardless of whether the codisposal or MSW burning mode was selected. With an assumed 85-percent plant availability and start-up of full-scale operations by 1985, an energy recovery facility for DeKalb County initially would need 1,200 TPD₇ of installed capacity. Three technology alternatives were considered:

- Alternative 1: Rehabilitation and modernization of the two existing 300-TPD₇ rotary kiln incinerators at Camp Road and on-site addition of a 600-TPD₇ MBWW producing steam to drive a condensing turbine generator. Under this alternative, either the MSW only or codisposal mode would be possible. Electrical power generated would be wheeled via GP lines to the Snapfinger AWTP and water filtration plant, and the balance of power would be sold directly to GP.
- Alternative 2: Rehabilitation and modernization of the two existing incinerators at Camp Road to burn MSW only and construction of a 600-TPD₇ MBWW at the Snapfinger AWTP burning both MSW and sludge to produce steam and then generate electricity. The electrical power generated at the Snapfinger facility would be tied directly to the AWTP. The power at the existing facility would be tied into the GP grid for wheeling to the water filtration plant, with the balance sold directly to GP.

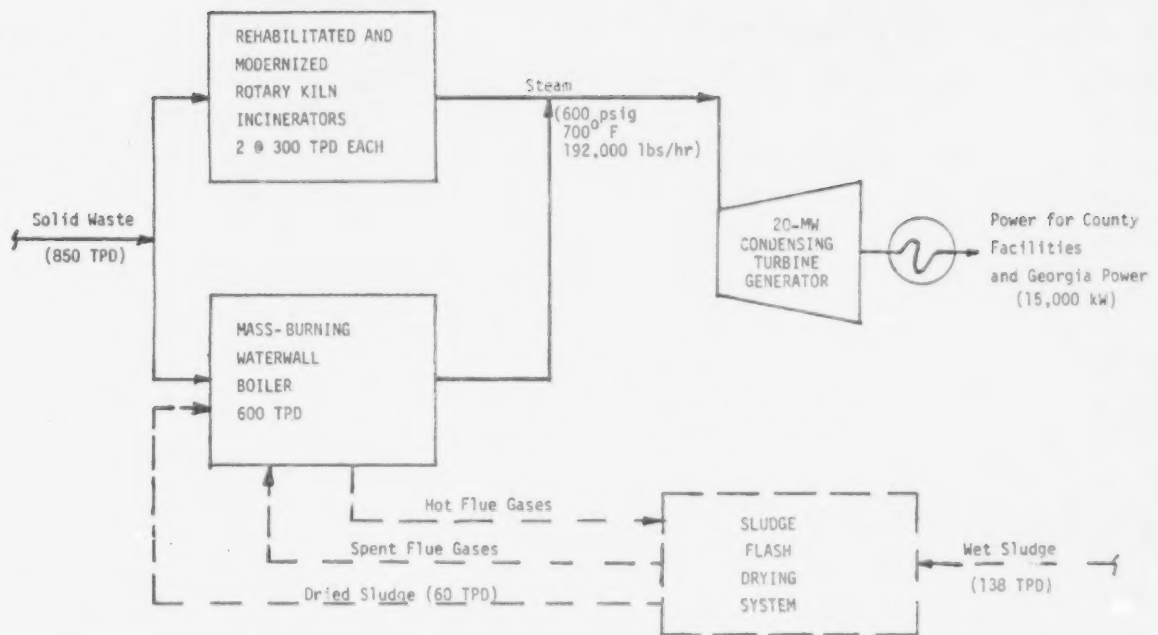
- Alternative 3. Construction of a new 1,200-TPD₇ MBWW plant at the Seminole landfill site for MSW burning only or at the Snapfinger site for codisposal of MSW and sludge to produce steam and electricity. If the plant were located at Seminole, electrical power would be wheeled via GP lines to the Snapfinger and water filtration plants, and the balance in excess of county requirements sold directly to GP. If the plant were located at the Snapfinger site, the electrical power produced would supply the AWTP needs directly. The remaining output would be wheeled to the water filtration plant, with the excess sold directly to GP.

A more detailed description of each alternative is given in the following subsections.

Alternative 1. As shown in Figure 3-1, Alternative 1 involves rehabilitating the existing incinerators at Camp Road (600-TPD₇ design capacity) and the on-site addition of a 600-TPD₇ MBWW boiler for a total MSW processing capacity of 1,200 TPD₇. Under Alternative 1, two options were considered: (1) solid waste disposal only; and (2) codisposal of solid waste and sewage sludge. The combustion of MSW (and sludge in codisposal) would produce steam at 600 psig, 700°F for generating electricity in a 20-megawatt (MW) condensing turbine generator. Under the codisposal option, a direct sludge drying system would be included. While most of the steam exhausted by the turbine would have to be condensed, some of the steam would be extracted for feedwater heating and other uses. Electrical power generated would be tied into the GP grid, with the necessary power wheeled to the county facilities and the balance sold to GP.

Under the codisposal option, wet sludge (35-percent solids) produced at the Snapfinger AWTP would be hauled by truck to storage at the Camp Road site. The sludge would then be conveyed from storage to the sludge drying equipment, where it would be dewatered using flash drying. During flash drying, hot furnace gases would be directed to the dryers to vaporize the water entrained in the wet sludge. The extracted odorous vapors would be returned to the furnace for elimination. Dried sludge (80-percent solids) would either be blown back directly to the furnace or conveyed to a small storage bin, from which it would be pneumatically conveyed to the new MBWW boiler.

FIG. 3-1. FLOW DIAGRAM: ALTERNATIVE 1--UTILIZATION OF EXISTING INCINERATORS AND NEW MBWW BOILER AT THE CAMP RD. SITE



Under both the solid waste only and codisposal options, MSW would be dumped in the existing storage pit, which would have to be enlarged to handle the additional capacity. If codisposal were selected, the new boiler would require at least one new crane and bucket feed system. Residue from the furnace bottom and fly ash hoppers would be collected and hauled to the county's landfill.

To determine the rehabilitation and modernization requirements of the two existing rotary kiln incinerators, a more detailed engineering assessment of the plant would be necessary. A cursory examination of the existing plant conducted as part of this preliminary investigation revealed that the plant is in reasonably good condition. At a minimum, however, refractories and grates would probably be required.

In a recent study⁶ of two similar 300-TPD₇ rotary kiln incinerators in Montgomery County, Ohio, the following improvements were identified as essential to generate steam and comply with pertinent codes:

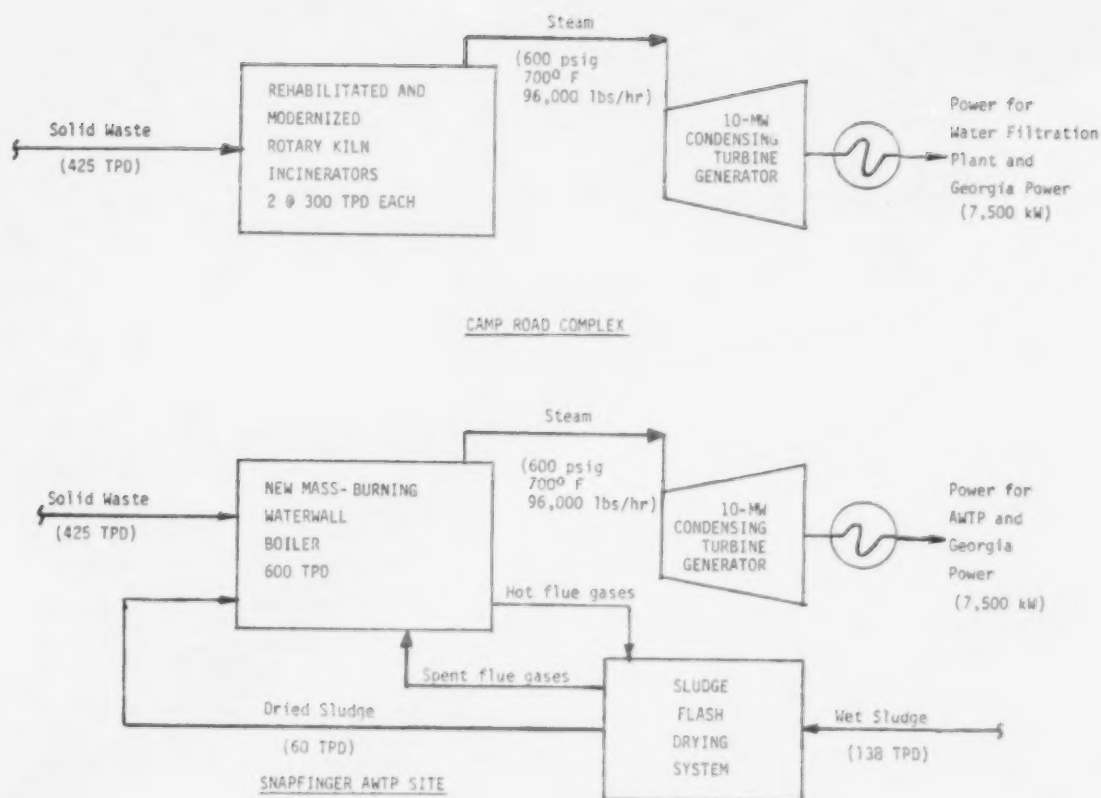
1. Modify charging chutes
2. Modify primary and secondary chambers and stokers
3. Repair rotary kilns
4. Install new automated combustion air system
5. Replace gas conditioning chambers with waste heat boilers and economizers
6. Add precipitators, fans, ductwork, etc.

For the purposes of this analysis, the above modifications were considered to be also required for the Camp Road facilities.

Alternative 2. As shown in Figure 3-2, Alternative 2 involves the same technology described in the codisposal option of Alternative 1. The major difference between the two alternatives is the siting of the new MBWW portion of the proposed recovery plant at the Snapfinger AWTP site, instead of at the Camp Road site. In addition, this alternative addresses codisposal only. The new 600-TPD₇ plant would handle all of the solid waste generated in the southern portion of the county, as well as the sludge from the wastewater plant.

⁶ William F. Cosulich Associates, P.C., Technical and Economic Feasibility Study of North & South Incinerator Rehabilitation-Conversion, prepared for Montgomery County, Ohio, Department of Environmental Services, March 1978.

FIG. 3-2. FLOW DIAGRAM: ALTERNATIVE 2--SPLIT-SITE UTILIZATION
OF EXISTING INCINERATORS AT CAMP RD. COMPLEX AND
NEW MBWW CODISPOSAL PLANT AT SNAPPINGER



A 10-MW turbine generator would be installed at each site. Power generated at the Camp Road site would be wheeled to the water filtration plant. The output of the 10-MW turbine generator at the Snapfinger plant would be tied directly into the wastewater plant's electrical power system, saving the wheeling charge fee. Excess power generated by either plant would be sold to GP.

Alternative 3. As shown in Figure 3-3, this alternative involves the construction of a completely new 1,200-TPD₇ mass-burning waterwall-based energy recovery facility. Two options were investigated: (1) solid waste disposal only, with a new plant located at the Seminole landfill site, and (2) the codisposal of solid waste and sewage sludge in a new plant located at Snapfinger.

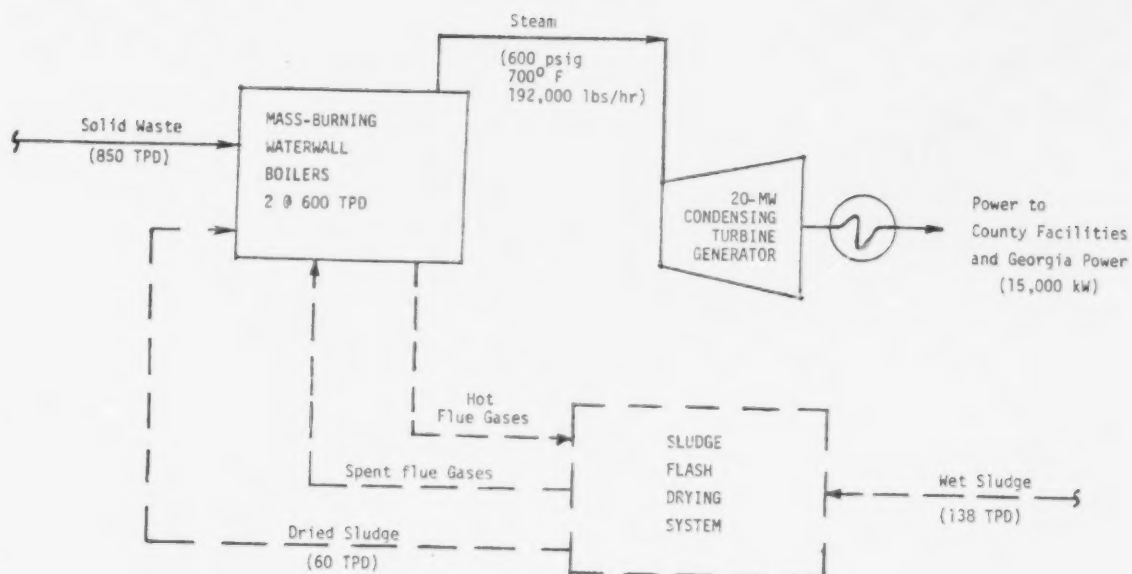
Under the solid waste only option, MSW received would be dumped in a storage pit having sufficient capacity to allow the plant to operate nights, weekends, or holidays. The buckets feed the furnace charge hoppers, from which ram-type feeders distribute refuse over the stoker grates. Ash from the furnace would then be discharged into a quench system and subsequently landfilled. Electrostatic precipitators would be installed to remove particulates from the combustion gas stream. Steam generated from the boilers would be fed into a common header, supplying steam to the 20-MW condensing turbine generator.

Under the codisposal option, furnace off-gases would be diverted to the sludge drying system. Sludge (35-percent solids) would be fed into flash dryers and discharged at 80-percent solids. Odorous vapor-laden gases would be recycled back into the furnace for deodorization and particulate removal. The dried sludge could either be carried to the incinerator by the drying gases or separated by cyclone from the drying gases and pneumatically conveyed to the furnace.

If the plant were located at the Seminole landfill, the electrical power generated would be wheeled to the Snapfinger facility and water filtration plant, with excess power sold directly to GP.

Siting the new disposal facility contiguous to the Snapfinger plant would allow a direct electricity tie, thus saving wheeling charges.

FIG. 3-3. FLOW DIAGRAM: ALTERNATIVE 3--
NEW MBWW SOLID WASTE FACILITY AT SEMINOLE
OR NEW MBWW CODISPOSAL FACILITY AT SNAPPFINGER



Energy Recovery Calculations

To determine the amount of electrical power generated for each alternative (see Figures 3-1 through 3-3), the following conservative assumptions were made:

- The solid waste has a heat content of 4,600 Btu/lb.
- The net sludge heat contribution is small.
- The efficiency and availability of the rotary kiln waste heat boilers is equal to that of the mass-burning waterwall units.
- The quantities of steam and electricity produced by each alternative are the net amounts after in-plant usage.

Based on these assumptions, it is expected that approximately 15,000 kW of power will be available for sale to GP or wheeled to county facilities. On an annual basis, with a plant availability of 85 percent, approximately 112,000,000 kWh of power could be produced.

CHAPTER 4. ECONOMIC EVALUATION OF ENERGY RECOVERY ALTERNATIVES

Once the technology assessment is completed, an economic analysis is necessary to compare the cost benefits of the proposed alternatives with those of the existing disposal system and to eliminate those alternatives that are not economically feasible. It is important to remember that, because this preliminary feasibility study was undertaken at the conceptual engineering level, the economic estimates reported in this chapter are preliminary in nature.

In formulating the economic analyses of the three energy recovery alternatives, certain assumptions were made concerning project sponsorship, ownership, procurement, and financing. To overcome the various legal and institutional barriers to the implementation of energy recovery, it was assumed, as allowed by Georgia State law (Code Chapter 69-15a), that an independent County Resource Recovery Development Authority would be formed to provide ownership, financing, and procurement of any proposed recovery project. To minimize the financial and technical risks of resource recovery to the authority, it was also assumed that the design, erection, start-up, and operation of the facility would employ the turnkey approach.

Code Chapter 69-15a limits the method of financing available to a Resource Recovery Development Authority to revenue bonds. Use of a turnkey construction contract with a companion operating contract procurement enhances the likelihood that revenue bonds will be sold because long-term system performance guarantees can be obtained from systems vendors who can commit substantial corporate resources to fulfill guarantees. These guarantees may include: system energy efficiencies, processing capacity, quality and quantity of recovered energy and material, and quantity of residuals requiring ultimate disposal. In some cases, minimum product revenue guarantees and financial coverage in the event of certain kinds of default may also be obtained. Such guarantees and risk coverage are not usually attainable with A&E or turnkey-only procurement.

In the remainder of this chapter, the preliminary economic analysis of the three technical alternatives is presented, as well as a comparison of their estimated costs and current disposal costs.

Preliminary Economic Analysis of Alternatives

In this section, the total disposal costs of the proposed alternatives are given and the methodology used to derive these cost estimates is described.

Estimated costs of the energy recovery alternatives are as follows:

	Energy Recovery MSW Disposal Only		Energy Recovery Codisposal		
	Alt.1	Alt.3	Alt.1	Alt.2	Alt.3
Annual Net Disposal Costs (1984 \$1,000)	8,310	9,140	8,720	9,535	9,340

For detailed cost estimates and calculations for bond requirements, annual debt services, operating and maintenance costs, and revenues, see Tables A-1 through F in the appendix.

Below, the derivation of the estimates for the various cost components is described.

Capital Costs. Capital costs are given in the cost summary tables in the appendix (Tables A-2, B-1, and C-1). Construction and equipment costs were obtained from equipment vendors and recent resource recovery feasibility studies performed by this and other consultants, and are based on last quarter 1979 prices. The majority of these cost estimates are budgetary in nature. Engineering, contractor, and miscellaneous costs, including spare parts inventory, start-up, acceptance testing, and contingencies, were derived from detailed engineering cost estimates of similar systems performed by this consultant. Costs for legal services and engineering design reports are typical for projects of this magnitude.

Bond Issue Costs. The bond issue is larger than the capital cost estimate because of the need to finance the cost of the plant until it is generating revenue, the need to create reserves to guarantee payment in the event of unforeseen events, and the cost of issuing the bond. These inflating factors include interest during construction to cover

interest payments due on proceeds of the bond issue until revenues are generated by the energy recovery facility. Four years' coverage for interest payments during the construction period should be sufficient. A Debt Service Reserve Fund, equivalent to 1 year's interest costs, and underwriter's fees, representing 2.5 percent of the total bond issue, are typically required for revenue bond issues for resource recovery projects of this magnitude. These financing costs are partially offset by interest earned on the Debt Service Reserve Fund and by interest earned on the bond proceeds, which are disbursed gradually throughout the construction period.

Operating and Maintenance Costs. Tables A-2, B-2, and C-2 in the appendix give O&M costs for the three alternatives. These costs include cost or expense projections for labor, equipment maintenance, residual disposal, insurance, replacement sinking funding, and the operator's fee. Estimates are based on expected plant performance and historical data from operating facilities. All costs were adjusted to reflect labor and utility rates prevailing in DeKalb.

In developing the cost projection for these elements, annual escalators of 10 percent for labor and 7 percent for residual disposal were assumed.

Revenues. Estimated energy revenues for the three alternative are given in Tables A-2, B-2, and C-2 in the appendix. Energy revenues result from the sale of electricity to the two county facilities (the existing water filtration plant and the future Snapfinger AWTP) and the sale to GP of electricity generated in excess of the requirements of these two facilities. Revenues from the sale of electricity to county facilities would be reduced by the wheeling charges levied by GP for use of its transmission lines and equipment. Preliminary contact with GP personnel indicates that guidelines for determining the costs of providing wheeling services have not yet been formulated by the Federal Power Commission, nor have they been addressed at the Georgia State level.

An estimate of 5 mils/kWh for wheeling charges was used based on a "best guess" suggestion by a company representative. It was also suggested that a price of 12 mils/kWh would approximate GP's current costs of purchasing power from the regional power exchange.

For preliminary estimating purposes, revenues resulting from the sale of electricity to the county facilities were calculated using a cost of electricity of 35 mils/kWh (3.5¢/kWh) and subtracting for an assumed wheeling charge of 5 mils/kWh. Electricity sold directly to GP was priced at 12 mils/kWh. Electricity revenues to each party are assumed to escalate by 10 percent annually, reflecting increases in the utility's costs per kWh.

Because the systems under consideration would have an 85-percent availability factor, back-up power must be available from either GP or provided by standby generating capability at the two county facilities. For purposes of this analysis, it was assumed that back-up power would be purchased from the utility. In the event that more definitive demand charge cost information becomes available, the economics of purchasing back-up power versus a standby generating capability can be evaluated.

Eligibility for Federal Grant. Title II of Public Law 92-500 as amended (the Clean Water Act of 1977) authorizes the federal government to award grants to communities, regions, or states for the purpose of constructing water pollution control facilities. The Clean Water Act of 1977 stresses innovative solutions to improved water quality, specifically citing codisposal technologies as a viable option.

While a codisposal facility qualifies as an innovative solution to water quality problems, an additional criterion must be met. To be eligible for a federal grant, it must be demonstrated that a dual-purpose technology, e.g., a codisposal facility, is more cost-effective than the sum of two or more single-purpose facilities it would replace. In the case of a codisposal facility, its costs were compared to the sum of the costs of separate, independent solid waste and sludge disposal systems.

A 20-year present value analysis is used to determine cost effectiveness. In this analysis, the capital costs and present value of O&M expenses of each most cost-effective, single-purpose option were combined and compared to the capital costs and present value of O&M expenses of the multi-purpose system. If the multi-purpose system is found to be more cost-effective than the sum of capitalized costs for each single-purpose system, it will qualify for federal grant consideration. Currently, there is some uncertainty in the manner in which the grant awards are calculated. For purposes of this report, it was assumed that the grant award would be

85 percent of 115 percent of the capital cost of the least expensive single-purpose system.

For the purposes of analysis, it was assumed that the minimum grant available to the least expensive single-purpose facility would be approximately \$2.44 million. The total installed capital cost of the least expensive single-purpose facility (the additional gas-fired multiple hearth furnace) was estimated at \$2.5 million, based on conversations with equipment vendors.

Accuracy of Cost Information. It is important to note that the cost information used in this investigation was at the conceptual design level only. The American Society for Cost Engineers has suggested that, at this level, capital cost estimates are within the ± 25 -percent probable accuracy range. In the preliminary design stage, after design parameters have been better defined, the probable cost estimate accuracy is increased to ± 12 percent. Advancement of the design to the detailed construction bid stage, increases capital cost accuracy to within the ± 3 -percent range.

As part of this preliminary feasibility study, an error analysis was performed on the disposal costs for energy recovery systems. The analysis used standard methods for evaluating the effects of a compound error contribution made by several inputs. Because disposal costs are related to debt service, O&M costs, and revenues, each of these factors affects the total error. Debt service is a function of capital cost, the bond multiplier, and the capital recovery factor. O&M costs are primarily a function of labor and equipment replacement costs. Revenue flow from the sale of electricity is directly tied to three variables: (1) the future cost of electrical power to county facilities; (2) the price GP would be willing to pay for the excess power generated; and (3) the wheeling charge paid to GP for use of its transmission system. At this point in time, the prices and costs for these variables are to be considered only estimates. Until federal and state regulations are better established with respect to wheeling rates and the price paid for purchased power from energy recovery facilities, project

economic analysis will be subject to uncertainty. The structure of the business arrangement between GP and the sponsor of the energy recovery facility will also affect project economics.

The results of the error analysis showed that disposal cost estimates were in the ± 35 -percent probable accuracy range.

Current Disposal Costs of Existing System

In the following subsections, the current disposal costs of the county's existing solid waste landfilling and sludge incineration system are given.

MSW Disposal. In 1978, the county was able to minimize disposal costs through direct landfill of approximately 34 percent of the total MSW generated in the county at the Henrico Road landfill. In addition, transportation costs were reduced because the county was able to haul around 16 percent of the MSW directly to that landfill. As a result, county records indicate that the annual costs for disposal in 1978 were as follows:

Buford Shredding	\$ 725,000	
Central Transfer Station and Haul	760,000	
Landfill Costs	<u>1,182,000</u>	
TOTAL	\$2,667,000	1978 throughput ÷ 274,089 (in tons) = \$9.73/ton

Because the BFI-owned Henrico Road landfill is now closed, disposal costs to the county can be expected to increase sharply because:

- Shredding costs are greater as all waste has to be shredded prior to disposal at the county-owned Seminole landfill because of conditions agreed to by the county when it acquired the Seminole site.
- Transportation costs are greater because of increased hauling to Buford and back-hauling to the Seminole landfill.
- Annual operating costs at Seminole are higher than those at the BFI landfill. This higher cost at Seminole reflects the higher operating standards required there relative to those provided by BFI.

A first-order estimate of the county's solid waste disposal system costs, based on the closing of the BFI landfill, indicates that annual costs could be increased on the order of \$3.00 per ton (excluding inflation), or about 30 percent greater than those experienced in 1978, resulting in a current disposal cost of about \$13/ton.

Sludge Disposal. According to county staff, the current disposal costs of sludge incineration at Snapfinger are estimated at \$115 per dry ton.

Comparison of Alternatives to Current Landfill Costs

As stated previously, current MSW disposal costs are likely to increase to \$13 per ton (1979) as a result of the closing of the BFI landfill. This disposal cost and the cost of existing sludge incineration must be compared in 1984 dollars to the estimated disposal costs for the various resource recovery alternatives summarized in Table 4-1 to determine the economic feasibility of resource recovery.

To escalate current disposal costs for MSW to the year 1984, it was assumed that the cost was comprised of three components: 10-percent fuel, 60-percent labor, and 30-percent equipment maintenance, which, in turn, were assumed to escalate at the annual rate of 15 percent, 7 percent, and 10 percent, respectively. The combination of these factors would escalate the current \$13 MSW disposal cost to \$19, corresponding to an annual average increase of about 8 percent.

Assuming gas-fired multiple-hearth incineration, personnel from the Dekalb County Water & Sewer Department estimate that sludge disposal costs will be \$90 per dry ton in 1984.

From the data in Table 4-1, the following conclusions can be arrived at:

- Current landfill disposal costs are likely to be substantially lower than the costs of energy recovery systems burning MSW only.
- The net disposal costs for energy recovery in the codisposal mode are competitive with total 1984 disposal costs for separate MSW and sludge disposal using current shredding/landfilling and incineration methods.

TABLE 4-1. Economic Comparison of Resource Recovery with Current Disposal Methods
1984 Dollar (x \$1,000)

	Resource Recovery MSW Disposal only Option		Resource Recovery Codisposal Options			Current Disposal Systems	
	ALT. 1 Utilizing Existing Incinerators + new MBWW Boiler at Camp Road	ALT. 3 Completely new MBWW System at Seminole	ALT. 1 Utilizing Existing Incinerators + new MBWW Boiler at Camp Road	ALT. 2 Split size same as ALT. 1 but new MBWW Boiler at Snapfinger	ALT. 3 Completely new MBWW Boilers at Snapfinger	MSW Shredder and Landfill	SLUDGE Gas-fired Multi-Hearth
Tons of Solid Waste in 1984	310,250	310,250	310,250	310,250	310,250	310,250	—
Tons of Sludge in 1984	—	—	25,550	25,550	25,550	—	21,900
Total Bond Size	\$ 67,050	\$ 73,630	\$ 66,500	\$ 70,640	\$ 73,060	1979 disposal cost/ton = \$13 escalated to \$19 in 1984 (8% escalation per year)	1979 disposal cost/dry ton = \$115
Total Annual O&M Costs	5,550	5,660	5,910	6,575	6,150		
Annual Debt Service	6,330	6,950	6,280	6,670	6,900		
Total Annual Costs	11,880	12,610	12,190	13,245	13,050		\$90 per ton in 1984
Less Revenues from sale of electri- cal power	3,470	3,470	3,470	3,710	3,710		
Net Disposal Costs	8,310	9,140	8,720	9,535	9,340	5,890 + 2,000 = 7,890 net disposal cost for MSW and sludge	

- Use of the existing incinerators could result in lower net disposal costs when compared to the costs of a completely new facility, either MSW only or codisposal.
- The net disposal costs of a split codisposal system (Alternative 2) could exceed those of a codisposal system located on one site.

When considering these preliminary economic conclusions, it is important to note that, with continued landfilling of 750 TPD of MSW, the Seminole Road landfill has a remaining life of only 20 years. Given the difficulties incurred in procuring this landfill site, it is likely to prove difficult for the county to acquire any additional landfill sites. If a resource recovery option were implemented, assuming processing of 1,000 TPD, the life of the Seminole Road landfill would be extended by some 27 years beyond the year 2000, as the daily volume of solid wastes to be landfilled would be reduced by 68 percent.

Revenues from Tipping Fees. The net disposal costs given in Table 4-1 will have to be made up by tipping fees for solid waste in the case of MSW burning only; if codisposal is opted for, disposal costs will have to be made up by tipping fees for solid waste and sludge.

When allocating tipping fees between MSW and sludge, a tipping fee is selected for one waste type to derive the required tipping fee for the other waste stream. In the case of Alternative I, the total revenues from tipping fees must offset the net annual disposal cost of \$8.3 million. For instance, selection of a \$19/ton MSW tipping fee would generate \$5.9 million in revenues, leaving \$2.4 million in revenues to be raised by the sludge tipping fees, translating into a tip fee of \$110/dry ton of sludge. Conversely, selection of the county-estimated sludge disposal cost of \$90/ton in 1984 would generate approximately \$2.0 million in revenues, leaving \$6.3 million to be raised by revenues from solid waste disposal tipping fees, translating into an approximate MSW tipping fee of \$20/ton.

The following formula explains the relationship among tipping fees,

O&M costs, and energy revenues:

$$\text{Net Disposal Costs} = \text{Sludge TF} + \text{MSW TF} = \text{O\&M} + \text{DS} - \text{R}$$

where: O&M = annual operating and maintenance costs
DS = annual debt service payment
R = annual revenues from sale of electrical power.

Because the economic success of the energy recovery alternatives depends on the revenues generated from the sale of power, the accuracy of the annual revenues estimate is of critical importance in determining the economic viability of a project. As discussed earlier in this chapter, the level of accuracy of the net disposal cost estimates was significantly affected by the uncertainty associated with wheeling rates and the price to be paid by GP for the excess electricity produced. Once firm wheeling rates and purchased power prices have been negotiated with GP, the revenues term (R) in the above equation can be recalculated as shown in Table B-2 in the appendix. Then, the above equation can be recalculated to derive a more accurate net disposal cost.

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TABLE A-1.
COST SUMMARY
FOR ALTERNATIVE 1: SOLID WASTE DISPOSAL ONLY
(\$1000)

Cost Category	1979 Dollars	Escalation Factor*	Dollars in Year of Disbursement
A. CONSTRUCTION & EQUIPMENT			
1. Site preparation & foundation	\$ 200	1.41	\$ 280
2. Buildings & auxiliary systems	2,000	1.50	3,000
3. Rehabilitation & modernization of rotary kiln incinerators	6,600	1.40	9,240
4. New mass-burning waterwall boiler & auxiliary equipment	12,750	1.40	17,850
5. Turbine generators & auxiliary equipment	6,800	1.40	9,520
SUBTOTAL CONSTRUCTION COSTS	28,350		39,890
B. ENGINEERING & CONTRACTOR COSTS			
6. Permits & Fees @ 1% construction costs	280	N/A	400
7. Engineering & Construction Manage- ment Costs @ 8% construction costs	2,270	N/A	3,200
8. Contractor Costs			
a. Performance Bond @ 0.5% con- struction costs	140	N/A	200
b. Profit @ 17%, Items 1 & 2	370	N/A	560
C. MISCELLANEOUS			
9. Spare Parts Inventory @ 2% Items 3 - 5	520	N/A	730
10. Start-up, Testing, & Acceptance @ 10% equipment costs, 2% building costs, 6 months O&M costs	1,900	N/A	2,600
11. Contingency @ 10% construction costs	2,840	N/A	4,000
TOTAL CAPITAL COST	\$36,670		\$51,580
D. FINANCING COSTS			
30% of Total Capital Cost (see Table F in Appendix)			15,470
TOTAL BOND SIZE			\$67,050

*See notes for Tables A-1, B-1, C-1, D-1, and E-1.

TABLE A-2.

ANNUAL OPERATING AND MAINTENANCE COSTS AND REVENUES
FOR ALTERNATIVE 1: SOLID WASTE DISPOSAL ONLY (\$1000)

Cost or Revenue Category	1979 Dollars	Escalation Factor	1984 Dollars
A. OPERATING & MAINTENANCE COSTS			
1. Labor (See Table A-3)	\$ 1,280	1.61	\$ 2,060
2. Equipment Maintenance Cost			
• 4% Capital Equipment Cost	1,050		1,470
3. Residue & Bypass Waste Disposal Costs			
• Fuel 120,000 mi/yr @ \$0.15/mi	20	2.00	40
• Landfill Costs			
- Residue	270	1.40	380
850 TPD x 0.85 x 0.2 x 365 x \$5.20*			
- Bypassed Waste	240	1.40	340
850 TPD x 0.15 x 365 x \$5.20			
4. Insurance			
• \$2.50/\$1000 Total Capital Costs	90		130
5. Replacement Sinking Fund for short-life equipment	400		560
6. Operating Fee			
• 13% of Items 1 - 4			570
TOTAL ANNUAL O & M			5,550
Plus:			
ANNUAL DEBT SERVICE (CRF** x Bond Size)			6,330
TOTAL ANNUAL COST			\$11,880

*Current landfill cost at Seminole Landfill.

**CRF: capital recovery factor = 0.09439, 7% interest for 20 years.

TABLE A-2. (continued)

Cost or Revenue Category	1979 Dollars	Escalation Factor	1984 Dollars
B. REVENUES			
1. Electrical Power sold to:			
● Snapfinger AWT			
3877 kW x 8760 $\frac{\text{hrs}}{\text{yr}}$ x 0.85 x \$0.035	\$ 1,010	1.610	\$ 1,770
● Water Filtration Plant			
3913 kW x 8760 $\frac{\text{hrs}}{\text{yr}}$ x 0.85 x \$0.035	1,020	1.610	1,640
● Georgia Power			
7210 kW x 8760 $\frac{\text{hrs}}{\text{yr}}$ x 0.85 x \$0.012	644	1.610	1,040
LESS COSTS FOR:			
● Wheeling			
7790 kW x 8760 $\frac{\text{hrs}}{\text{yr}}$ x 0.75 x \$0.005	290	1.610	470
● Demand Costs	315	1.610	510
TOTAL ANNUAL REVENUES			\$ 3,470

TABLE A-3.
ALTERNATIVE 1: PLANT MANPOWER REQUIREMENTS

Position	Hourly Rate	Number Required at 2080 hrs/yr each	1979 Dollars
Chief Engineer	\$9.00	1	\$ 18,700
Assistant Chief Engineer	8.50	1	17,700
Watch Engineer	8.50	4	70,700
Plant Manager	10.00	1	20,800
Clerical	3.50	3	21,800
Scale Operator	4.0	3	25,000
Tipping Floor Man	4.5	3	28,100
Crane Operators	5.0	8	83,200
Control Room Operator	7.50	4	62,400
Boiler Operator	8.50	12	212,200
Turbine Generator Operator	8.50	4	70,700
Lab Technician	7.00	1	14,600
Mechanics	6.00	12	149,800
Electricians	6.00	4	49,900
Laborers	4.50	8	74,900
Welders/Machinists	6.00	4	49,900
Ash Truck Driver	6.50	4	54,100
		77	\$1,024,500
Plus: 25% for fringe benefits			x 1.25
TOTAL for Solid Waste Disposal Only			\$1,280,600
TOTAL with addition of sludge disposal			
Add two truck drivers			
@ \$6.50/hr x 2080 $\frac{\text{hrs}}{\text{yr}}$ x 1.25 (fringe benefits) . .			33,800
GRAND TOTAL			\$1,314,400

TABLE B-1.
COST SUMMARY FOR
ALTERNATIVE 1: CODISPOSAL (\$1000)

Cost Category	1979 Dollars	Escalation Factor*	Dollars in Year of Disbursement
A. CONSTRUCTION & EQUIPMENT			
1. Site Preparation & Foundation	\$ 200	1.41	\$ 280
2. Buildings & Auxiliary	2,000	1.50	3,000
3. Rehabilitation & Modernization of Rotary Kiln Incinerators	6,600	1.40	9,240
4. New Mass-burning Waterwall Boiler & Auxiliary Equipment	12,750	1.40	17,850
5. Turbine Generators & Auxiliary Equipment	6,800	1.40	9,520
6. Sludge Transport, Feeding, & Drying Equipment	<u>1,100</u>	1.40	<u>1,540</u>
SUBTOTAL CONSTRUCTION COSTS	29,450		41,430
B. ENGINEERING & CONSTRUCTOR COSTS			
7. Permits & Fees @ 1% construction costs	290	N/A	420
8. Engineering & Construction Management Costs @ 8% construction costs	2,360	N/A	3,320
9. Contractor Costs			
a. Performance Bond @ 0.5% construc- tion costs	150	N/A	200
b. Profit @ 17%, Items 2 & 3	370	N/A	560
C. MISCELLANEOUS			
10. Spare Parts Inventory @ 2% Items 3 - 6	550	N/A	770
11. Start-up, Testing, & Acceptance @ 10% equipment costs, 2% building costs, 6 months O & M costs	1,900	N/A	2,700
12. Contingency @ 10% Construction Costs	2,950	N/A	4,150
SUBTOTAL CAPITAL COST	38,020		53,550
Less: Wastewater Grant Funding	N/A		<u>2,400</u>
TOTAL CAPITAL COST	N/A		\$51,150
FINANCING COSTS			
30% of Total Capital Cost (See Table F in appendix)			<u>15,350</u>
TOTAL BOND SIZE			\$ 66,500

See notes for Tables A-1, B-1, C-1, D-1, and E-1.

TABLE B-2.
ANNUAL OPERATING AND MAINTENANCE COSTS AND REVENUES
FOR ALTERNATIVE 1: CODISPOSAL (\$1000)

Cost or Revenue Category	1979 Dollars	Escalation Factor	1984 Dollars
A. OPERATING & MAINTENANCE COSTS			
1. Labor (See Table A-3)	\$ 1,310	1.61	\$ 2,110
2. Equipment Maintenance Cost			
• 4% Capital Equipment Cost	1,090		1,530
3. Residue & Bypass Waste Disposal Costs			
• Fuel 120,000 mi/yr @ \$0.15/mi	20	2.00	40
• Landfill Costs			
- Residue	320	1.40	450
MSW 850 TPD x 0.85 x 0.2 x 365 x \$5.20*			
Sludge 88 TPD x 0.85 x 0.35 x 365 x \$5.20			
- Bypassed Waste	265	1.40	370
MSW 850 TPD x 0.15 x 365 x \$5.20			
Sludge 88 TPD x 0.15 x 365 x \$5.20			
4. Sludge Transportation			
• 81,000 mi/yr x \$0.15/mi	10	2.00	20
5. Insurance			
• \$2.50/\$1000 of Total Capital Costs	90		130
6. Replacement Sinking Fund			
• Replacement for short-life equipment e.g., cranes, buckets	470		660
7. Operating Fee			
• 13% of Items 1 - 5	400		600
TOTAL ANNUAL O & M	4,085		5,910
Plus:			
ANNUAL DEBT SERVICE (CRF**x Bond Size)	N/A		6,280
TOTAL ANNUAL COST	N/A		\$ 12,190

* Current landfill cost at Seminole Landfill.

** CRF: capital recovery factor = 0.09439, 7% interest for 20 years.

TABLE B-2. (continued)

Cost or Revenue Category	1979 Dollars	Escalation Factor	1984 Dollars
B. REVENUES			
1. Electrical Power sold to:			
● Snapfinger AWP	\$1,010	1.61	\$1,770
3877 kW x 8760 $\frac{\text{hrs}}{\text{yr}}$ x 0.85 x \$0.035			
● Water filtration plant	1,020	1.61	1,640
3913 kW x 8760 $\frac{\text{hrs}}{\text{yr}}$ x 0.85 x \$0.035			
● Georgia Power	645	1.61	1,040
7210 kW x 8760 $\frac{\text{hrs}}{\text{yr}}$ x 0.85 x \$0.012			
Less costs for:			
● Wheeling	290	1.61	470
3913 kW x 8760 $\frac{\text{hrs}}{\text{yr}}$ x 0.85 x \$0.005			
● Demand Costs	315	1.61	510
TOTAL ANNUAL REVENUES			\$ 3,470

TABLE C-1.

COST SUMMARY FOR ALTERNATIVE 2: SPLIT-SITE CODISPOSAL

Cost Category	1979 Dollars	Escalation Factor*	Dollars in Year of Disbursement
A. CONSTRUCTION & EQUIPMENT			
1. Site Preparation & Foundation	\$ 200	1.41	\$ 280
2. Buildings & Auxiliary Systems	2,000	1.50	3,000
3. Rehabilitation & Modernization of Rotary Kiln Incinerators	6,600	1.40	9,240
4. New Mass-burning Waterwall Boiler & Auxiliary Equipment	12,750	1.40	17,850
5. Turbine Generators & Auxiliary Equipment	8,260	1.40	11,600
6. Sludge Storage, Drying, & Feeding Equip- ment	<u>1,000</u>	1.40	<u>1,400</u>
SUBTOTAL CONSTRUCTION COSTS	30,810		44,070
B. ENGINEERING & CONTRACTOR COSTS			
7. Permits & Fees @ 1% construction costs	300	N/A	440
8. Engineering & Construction Management Costs @ 8% construction costs	2,460	N/A	3,530
9. Contractor Costs			
a. Performance Bond @ 0.5% construction costs	150	N/A	220
b. Profit @ 17%, Items 1 & 2	370	N/A	560
C. MISCELLANEOUS			
10. Spare Parts Inventory @ 2%, Items 3 - 6	570	N/A	820
11. Start-up, Testing, & Acceptance @ 10% equipment costs, 2% building costs, & 6 months O & M costs	1,900	N/A	2,700
12. Contingency @ 10% construction costs	<u>3,080</u>		<u>4,400</u>
SUBTOTAL CAPITAL COST	39,640		56,740
Less: Wastewater Grant Funding	N/A		<u>2,400</u>
TOTAL CAPITAL COST	N/A		\$ 54,340
D. FINANCING COSTS			
30% of Total Capital Costs (See Table F in Appendix)			16,300
TOTAL BOND SIZE			\$ 70,640

* See notes for Tables A-1, B-1, C-1, D-1, and E-1.

TABLE C-2.

ANNUAL OPERATING AND MAINTENANCE COST AND REVENUES
FOR ALTERNATIVE 2: SPLIT-SITE CODISPOSAL (\$1000)

Cost or Revenue Category	1979 Dollars	Escalation Factor	1984 Dollars
A. OPERATING & MAINTENANCE COSTS			
1. Labor (See Table C-3)	\$ 1,660	1.61	\$ 2,670
2. Equipment Maintenance Cost			
• 4% Capital Equipment Cost	1,120		1,600
3. Residue and Bypass Waste Disposal Costs			
• Fuel 190,000 mi/yr @ \$0.15/mi	15	2.00	30
• Landfill Costs			
- Residue			
850 TPD x 0.85 x 0.2 x 365 x \$5.20*	320	1.40	450
88 TPD x 0.85 x 0.35 x 365 x \$5.20			
- Bypassed Waste			
MSW 850 TPD x 0.15 x 365 x \$5.20	265	1.40	370
Sludge 88 TPD x 0.15 x 365 x \$5.20			
4. Insurance			
• \$2.50/\$1000 of Total Capital Costs	90		125
5. Replacement Sinking Fund			
• Replacement for short-life equipment	470		660
6. Operating Fee			
• 13% of Items 1 - 4	440		670
TOTAL ANNUAL O & M	4,390		6,575
Plus:			
ANNUAL DEBT SERVICE (CRF** x Bond Size)	N/A		6,670
TOTAL ANNUAL COST	N/A		\$ 13,245

* Current landfill cost at Seminole Landfill.

** CRF: capital recovery factor = 0.09439, 7% interest for 20 years.

TABLE C-2. (continued)

Cost or Revenue Category	1979 Dollars	Escalation Factor	1984 Dollars
B. REVENUES			
1. Electrical Power sold to:			
● Snapfinger AWTP 3877 kW x 8760 $\frac{\text{hrs}}{\text{yr}}$ x 0.85 x \$0.035	\$ 1,010	1.61	\$ 1,770
● Water filtration plant 3913 kW x 8760 $\frac{\text{hrs}}{\text{yr}}$ x 0.85 x \$0.035	1,020	1.61	1,640
● Georgia Power 7210 kW x 8760 $\frac{\text{hrs}}{\text{yr}}$ x 0.85 x \$0.012	644	1.61	1,040
Less costs for:			
● Wheeling 3913 kW x 8760 $\frac{\text{hrs}}{\text{yr}}$ x 0.85 x \$0.005	145	1.61	230
● Demand Costs	315	1.61	510
TOTAL ANNUAL REVENUES			\$ 3,710

TABLE C-3.
ALTERNATIVE 2 - PLANT MANPOWER REQUIREMENTS

Position	Hourly Rate	Number Required at 2080 hrs/yr each		1979 Dollars
		Camp Rd. Complex	Snapfinger Facility	
Chief Engineer	\$9.00	1	-	\$ 18,700
Assistant Chief Engineer	8.50	-	1	17,700
Watch Engineer	8.50	4	4	141,400
Plant Manager	10.00	1	-	20,800
Clerical	3.50	2	1	21,800
Scale Operator	4.00	3	3	49,900
Tipping Floor Man	4.50	3	3	56,200
Crane Operators	5.00	4	4	83,200
Control Room Operator	7.50	4	4	124,800
Boiler Operator	8.50	8	4	212,200
Turbine Generator Operator	8.50	4	4	141,400
Lab Technician	7.00	1	-	14,600
Mechanics	6.00	8	4	149,800
Electricians	6.00	4	4	99,800
Laborers	4.50	4	4	74,900
Welders/Machinists	6.00	2	2	49,900
Ash Truck Driver	6.50	2	2	54,000
		55	44	\$1,331,100
		Plus: 25% for fringe benefits		x 1.25
		TOTAL		\$1,663,900

TABLE D-1.
COST SUMMARY FOR
ALTERNATIVE 3: SOLID WASTE DISPOSAL ONLY (\$1000)

Cost Category	1979 Dollars	Escalation Factor*	Dollars in Year of Disbursement
A. CONSTRUCTION & EQUIPMENT			
1. Site preparation & foundation	\$ 200	1.41	\$ 280
2. Buildings & auxiliary systems	2,800	1.50	4,200
3. Mass-burning waterwall boilers & auxiliary equipment	21,250	1.40	29,750
4. Turbine generator & auxiliary equipment	6,800	1.40	9,520
SUBTOTAL CONSTRUCTION COSTS	31,050		43,750
B. ENGINEERING & CONTRACTOR COSTS			
5. Permits & Fees @ 1% construction costs	310	N/A	440
6. Engineering & Construction Manage- ment Costs @ 8% construction costs	2,480	N/A	3,500
7. Contractor Costs			
a. Performance Bond @ 0.5% con- struction costs	160	N/A	220
b. Profit @ 17% Items 1 & 2	510	N/A	760
C. MISCELLANEOUS			
8. Spare Parts Inventory @ 2% Items 3 & 4	560	N/A	790
9. Start-up, Testing, & Acceptance @ 10% equipment costs, 2% building costs, 6 months O & M costs	2,000	N/A	2,800
10. Contingency @ 10% construction costs	3,100	N/A	4,380
TOTAL CAPITAL COST	\$ 40,170		\$ 56,640
D. FINANCING COSTS			
30% of Total Capital Cost (see Table F in Appendix)			16,990
	TOTAL BOND SIZE		\$ 73,630

* See notes for Tables A-1, B-1, C-1, D-1, and E-1.

TABLE D-2.
ANNUAL OPERATING AND MAINTENANCE COSTS AND REVENUES
FOR ALTERNATIVE 3: SOLID WASTE DISPOSAL ONLY (\$1000)

Cost or Revenue Category	1979 Dollars	Escalation Factor	1984 Dollars
A. OPERATING & MAINTENANCE COSTS			
1. Labor (See Table D-3)	\$ 1,190	1.61	\$ 1,920
2. Equipment Maintenance Cost			
• 4% Capital Equipment Cost	1,120		1,580
3. Residue & Bypass Waste Disposal Costs			
• Landfill Costs			
- Residue	270	1.40	380
850 TPD x 0.85 x 0.2 x 365 x \$5.20*			
- Bypassed Waste	240	1.40	340
850 TPD x 0.15 x 365 x \$5.20			
4. Insurance			
• \$2.50/\$1000 of Total Capital Costs	100		140
5. Replacement Sinking Fund			
• Replacement for short-life equipment	520		730
6. Operating Fee			
• 13% of Items 1 - 4	380		570
SUBTOTAL ANNUAL O & M	3,890		5,660
Plus:			
ANNUAL DEBT SERVICE (CRF** x Bond Size)	N/A		6,950
TOTAL ANNUAL COST	N/A		\$ 12,610

* Current landfill cost at Seminole Landfill.

** CRF: capital recovery factor = 0.09439, 7% interest for 20 years.

TABLE D-2. (continued)

Cost or Revenue Category	1979 Dollars	Escalation Factor	1984 Dollars
B. REVENUES			
1. Electrical Power sold to:			
● Snapfinger AWTP			
3877 kW x 8760 $\frac{\text{hrs}}{\text{yr}}$ x 0.85 x \$0.035	\$ 1,010	1.61	\$ 1,770
● Water Filtration Plant			
3913 kW x 8760 $\frac{\text{hrs}}{\text{yr}}$ x 0.85 x \$0.035	1,020	1.61	1,640
● Georgia Power			
7210 kW x 8760 $\frac{\text{hrs}}{\text{yr}}$ x 0.85 x \$0.012	644	1.61	1,040
Less costs for:			
● Wheeling			
7790 kW x 8760 $\frac{\text{hrs}}{\text{yr}}$ x 0.85 x \$0.005	290	1.61	470
● Demand Costs			
7790 kW x 8760 $\frac{\text{hrs}}{\text{yr}}$ x 0.15 x \$0.035	315	1.61	510
TOTAL ANNUAL REVENUES			\$ 3,470

TABLE D-3.
ALTERNATIVE 3: PLANT MANPOWER REQUIREMENTS

Position	Hourly Rate	Number Required at 2080 hrs/yr each	1979 Dollars
Chief Engineer	\$9.00	1	\$ 18,700
Assistant Chief Engineer	8.50	1	17,700
Watch Engineer	8.50	4	70,700
Plant Manager	10.00	1	20,800
Clerical	3.50	3	21,800
Scale Operator	4.0	3	25,000
Tipping Floor Man	4.5	3	28,100
Crane Operators	5.0	8	83,200
Control Room Operator	7.50	4	62,400
Boiler Operator	8.50	8	141,400
Turbine Generator Operator	8.50	4	70,700
Lab Technician	7.00	1	14,600
Mechanics	6.00	12	149,800
Electricians	6.00	4	49,900
Laborers	4.50	8	74,900
Welders/Machinists	6.00	4	49,900
Ash Truck Driver	6.50	4	54,000
		73	\$ 953,600
	Plus: 25% for fringe benefits		x 1.25
TOTAL for Solid Waste Disposal Only			\$1,192,000
TOTAL with Addition of Sludge Disposal			
Add two truck drivers			
@ \$6.50/hr x 2080 hrs/yr x 1.25 (fringe benefits). .			33,800
GRAND TOTAL			\$1,225,800

TABLE E-1.
COST SUMMARY FOR
ALTERNATIVE 3: CODISPOSAL (\$1000)

Cost Category	1979 Dollars	Escalation Factor*	Dollars in Year of Disbursement
A. CONSTRUCTION & EQUIPMENT			
1. Site preparation	\$ 200	1.41	\$ 280
2. Buildings & auxiliary systems	2,800	1.50	4,200
3. Mass-burning waterwall boilers & auxiliary equipment	21,250	1.40	29,750
4. Turbine generator & auxiliary equipment	6,800	1.40	9,520
5. Sludge transport, storage, drying, & feed equipment	<u>1,100</u>	1.40	<u>1,540</u>
SUBTOTAL CONSTRUCTION COSTS	32,150		45,290
B. ENGINEERING & CONTRACTOR COSTS			
6. Permits & Fees @ 1% construction costs	320	N/A	450
7. Engineering & Construction Management Costs @ 8% construction costs	2,570	N/A	3,620
8. Contractor Costs			
a. Performance Bond @ 0.5% construction costs	160	N/A	230
b. Profit @ 17% Items 1 & 2	510	N/A	760
C. MISCELLANEOUS			
9. Spare Parts Inventory @ 2% Items 3 - 5	580	N/A	820
10. Start-up, Testing, & Acceptance @ 10% equipment costs, 2% building costs, 6 months O & M costs	2,000	N/A	2,900
11. Contingency @ 10% construction costs	<u>3,220</u>	N/A	<u>4,530</u>
SUBTOTAL CAPITAL COSTS	40,150	N/A	38,600
Less: Wastewater Grant Funding	N/A	N/A	<u>2,400</u>
TOTAL CAPITAL COSTS	N/A	N/A	\$ 56,200
D. FINANCING COSTS			
30% of Total Capital Costs (see Table F in Appendix)			16,860
TOTAL BOND SIZE			\$ 73,060

* See notes for Tables A-1, B-1, C-1, D-1, and E-1.

TABLE E-2.

ANNUAL OPERATING AND MAINTENANCE COSTS AND REVENUES
FOR ALTERNATIVE 3: CODISPOSAL (\$1000)

Cost or Revenue Category	1979 Dollars	Escalation Factor	1984 Dollars
A. OPERATING & MAINTENANCE COSTS			
1. Labor (See Table D-3)	\$ 1,230	1.61	\$ 1,980
2. Equipment Maintenance Cost			
• 4% Capital Equipment Cost	1,170		1,640
3. Residue & Bypass Waste Disposal Costs			
• Fuel 120,000 mi/yr @ \$0.15/mi	20	2.00	40
• Landfill Costs			
- Residue	320	1.40	550
MSW 850 TPD x 0.85 x 0.2 x 365 x \$5.20*			
Sludge 88 TPD x 0.85 x 0.35 x 365 x \$5.20			
- Bypassed Waste	265	1.40	370
MSW 850 TPD x 0.15 x 365 x \$5.20			
Sludge 88 TPD x 0.15 x 365 x \$5.20			
4. Insurance			
• \$2.50/\$1000 of Total Capital Cost	100		140
5. Replacement Sinking Fund			
• Replacement for equipment with short life expectancy, e.g., cranes, buckets	590		830
6. Operating Fee			
• 13% of Items 1 - 4	390		600
SUBTOTAL ANNUAL O & M	4,195		6,150
Plus:			
ANNUAL DEBT SERVICE (CRF** x Bond Size)	N/A		6,900
TOTAL ANNUAL COST	N/A		\$ 13,050

* Current landfill cost at Seminole Landfill

** CRF = capital recovery factor = 0.09439, 7% interest for 20 years.

TABLE E-2. (continued)

Cost or Revenue Category	1979 Dollars	Escalation Factor	1984 Dollars
B. REVENUES			
1. Electrical Power sold to:			
• Snapfinger AWTP			
3877 kW x 8760 $\frac{\text{hrs}}{\text{yr}}$ x 0.85 x \$0.035	\$ 1,010	1.61	\$ 1,770
• Water Filtration Plant			
3913 kW x 8760 $\frac{\text{hrs}}{\text{yr}}$ x 0.85 x \$0.035	1,020	1.61	1,640
• Georgia Power			
7210 kW x 8760 $\frac{\text{hrs}}{\text{yr}}$ x 0.85 x \$0.012	644	1.61	1,040
LESS COSTS FOR:			
• Wheeling			
3913 kW x 8760 $\frac{\text{hrs}}{\text{yr}}$ x 0.85 x \$0.005	145	1.61	230
• Demand costs			
7790 kW x 8760 $\frac{\text{hrs}}{\text{yr}}$ x 0.15 x \$0.035	315	1.61	510
TOTAL ANNUAL REVENUES			\$ 3,710

TABLE F.
BOND FINANCING COSTS & CREDITS
PER \$1000 OF CAPITAL COST
AT VARIOUS BOND INTEREST RATES

	7%	8%	9%
Interest on Bonds during construction	360	430	500
One-year Debt Service Reserve Fund	120	140	150
Underwriter's Fee, Legal & Engineering Services	30	35	40
Less Interest Earned on Bond Proceeds, Bond Interest Fund and Debt Service Reserve Fund during construction	210	255	290
Bond Size	1300	1350	1400
Bond Multiplier	1.30	1.35	1.40

Note: In addition to the capital required for the cost of equipment procurement and construction of the facility, certain financing costs are associated when funding with revenue bonds. Until revenues from the sale of energy are available, funds are required to pay interest on the bonds during construction. Another requirement in using revenue bonds is a 1-year debt service reserve fund to cover 1 year's amortization on the plant. Other costs associated with revenue bond financing include the underwriter fee and legal and engineering services. These costs are partially offset by (1) interest earned on the bond proceed, which is disbursed over the entire construction period and (2) interest earned on the Bond Interest and Debt Service Reserve funds. The magnitude of financing costs is directly related to the bond interest rate and earned interest rates. Table F shows the effect on interest rates in determining the bond multiplier. For this study, a 7% bond interest rate for 20 years was selected, resulting in a Bond multiplier of 1.3. Increasing the bond interest rate 8% or 9% (as shown above) increases the bond multiplier to 1.35 and 1.40, respectively. In each case, the earned interest rate was assumed to be equal to the bond interest rate.

NOTES FOR TABLES

A-1, B-1, C-1, D-1, E-1

Escalation factors are based on extrapolations of trend line analysis, 1971-1978, for the following cost indexes by category, which were converted to a base year of 1979:

- Site Preparation and Foundation - Engineering News-Record Building Cost Index through First Quarter, 1982.
- Building-Engineering News-Record Building Cost Index until January, 1983.
- Process Equipment, Items 3, 4, and 5 - BLS General Purpose Machinery and Equipment Index through First Quarter, 1983.